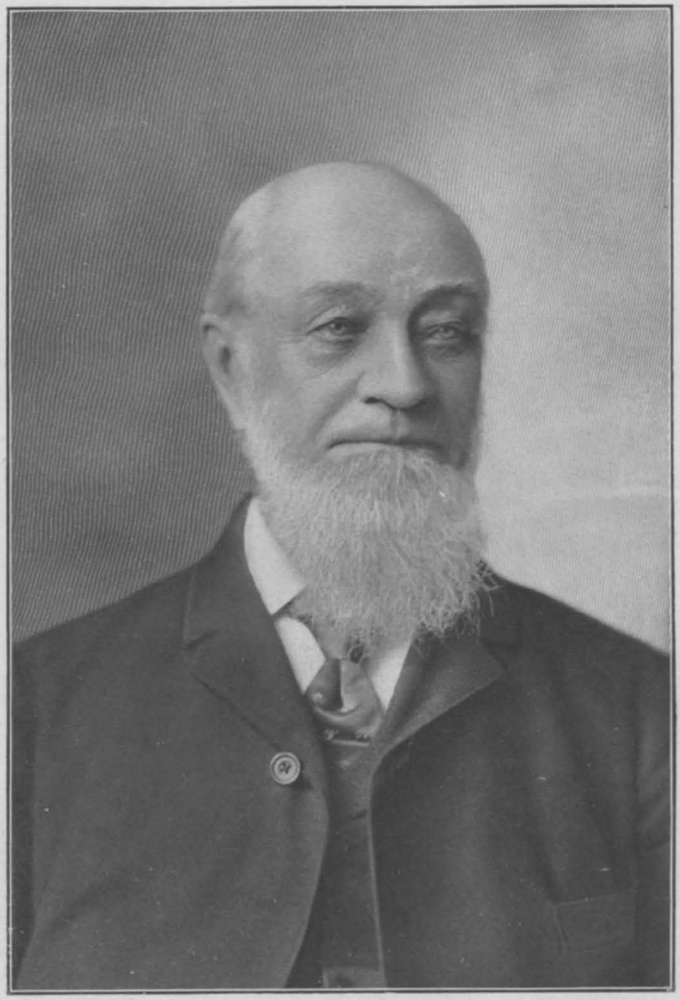

WILLIAM SAUNDERS.

[HORTICULTURIST AND LANDSCAPE GARDENER. BORN DECEMBER 7, 1822; DIED SEPTEMBER 11, 1900.]

# YEARBOOK

OF THE

# UNITED STATES

# DEPARTMENT OF AGRICULTURE.

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# 1900.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1901.

[CHAPTER 23, Stat. at L., 1895.]

AN ACT providing for the public printing and binding and the distribution of public documents.

* * * * * * *

Section 73, paragraph 2:

The Annual Report of the Secretary of Agriculture shall hereafter be submitted and printed in two parts, as follows: Part One, which shall contain purely business and executive matter which it is necessary for the Secretary to submit to the President and Congress; Part Two, which shall contain such reports from the different Bureaus and Divisions, and such papers prepared by their special agents, accompanied by suitable illustrations, as shall, in the opinion of the Secretary, be specially suited to interest and instruct the farmers of the country, and to include a general report of the operations of the Department for their information. There shall be printed of Part One, one thousand copies for the Senate, two thousand copies for the House, and three thousand copies for the Department of Agriculture; and of Part Two, one hundred and ten thousand copies for the use of the Senate, three hundred and sixty thousand copies for the use of the House of Representatives, and thirty thousand copies for the use of the Department of Agriculture, the illustrations for the same to be executed under the supervision of the Public Printer, in accordance with directions of the Joint Committee on Printing, said illustrations to be subject to the approval of the Secretary of Agriculture; and the title of each of the said parts shall be such as to show that such part is complete in itself.

# PREFACE.

In spite of efforts toward diminishing the somewhat inconvenient bulk of the Yearbook, the present edition contains as many pages as its predecessors, and is more profusely illustrated. This volume, however, contains, besides the Report of the Secretary and the Appendix, thirty-one articles, five more than last year. With one exception, every article was prepared by an employee of the Department, and each Division of original work is represented by one or more articles. Every article, moreover, except those prepared in the Division of Publications, covers some important line of work carried on in the Bureau, Division, or Office from which it emanated. Thus, the Yearbook for 1900 differs from some of its predecessors, which were more specially devoted to a review of the work of the several Divisions, but it is, nevertheless, distinctively representative of the work of the Department. The illustrations comprise eighty-seven plates, nine of them colored, and eighty-eight text figures.

Two of the articles, which were prepared in the Division of Publications, while not relating directly to the work of the Department or, indeed, to practical agriculture, will, it is believed, be found of great interest to American agriculturists. The subject of rural free delivery is so closely allied to the convenience and comfort of farm life, and has so greatly developed in recent years under the fostering care of the Government, that it seems to have a most appropriate place in a volume devoted, as is the Yearbook of the Department of Agriculture, to supplying the American farmer with useful information on all subjects pertaining to his life and work.

The work done, in a long life devoted to agriculture, horticulture, and kindred interests, by the late Mr. William Saunders is the subject of a brief notice by the Editor, which will, it is believed, fully justify the prominent place given to his memory in this edition, Mr. Saunders's portrait occupying the place of honor as the frontispiece.

Paragraph 2 of section 73 of the public printing and binding act of January 12, 1895, which precedes this preface (p. 2), affords explanation to those not already fully familiar with the Yearbook of the Department, of its proper place as a part of the Annual Report of the Secretary, and by reference thereto it will be seen that the Secretary's individual report, which opens every volume of the Yearbook, is reprinted in order "to include a general report of the operations of the Department," as required by law.

In the Appendix, which it is desired to make an indispensable book of reference to the farmer, the agricultural directory feature, introduced in 1899, has been continued. It has been revised and corrected as nearly as possible to March 1, 1901, with the exception of that part covering the organization of the Department. All agricultural associations and societies whose addresses are known were consulted. In some instances our requests for information were not answered, and in such cases the names which appeared in the Yearbook of 1899 have been dropped. While the limits of the Appendix will make it absolutely necessary to confine this directory to associations which are either National or State, it is earnestly desired to make it, with this restriction, as complete as possible, and the officers of all agricultural, horticultural, live stock, and other associations established in the interest of agriculture are cordially invited to avail themselves of an opportunity for record in a publication which yearly finds its way into the homes of half a million farmers.

A new feature of the Appendix is the publication of requirements for admission to the agricultural departments of the land-grant colleges, and the cost of attendance. As the Yearbook goes into the hands of many farmers whose sons may be desirous of attending college, it is believed this article will be found very useful.

The statistics of farm crops, supplied, as usual, by the Statistician of the Department, have been rearranged so as to present together the facts and figures relating to each crop, thus affording one complete view of results for a particular crop for the year. This change will, it is believed, be found especially convenient and time saving to farmers who have occasion to consult these figures in studying and planning their operations.

Altogether, including the Appendix, there is not a single Bureau, Division, or Office of the Department which has not contributed valuable matter to the present book, and every Division is, consequently, entitled to share whatever credit attaches to the work.

The care invariably bestowed upon the mechanical work and the earnest effort made to issue the Yearbook promptly, in spite of the enormous amount of work involved in the publication of a volume in an edition of 500,000 copies, call for the warmest acknowledgment on our part to the Public Printer and his principal assistants.

GEO. WM. HILL,
*Editor.*

WASHINGTON, D. C., *April 24, 1901.*

# CONTENTS.

Appendix—Continued.

# ILLUSTRATIONS.

PLATES.

## TEXT FIGURES.

# YEARBOOK

OF THE

# U. S. DEPARTMENT OF AGRICULTURE.

## REPORT OF THE SECRETARY.

To the President:

I have the honor to report upon the work of the Department of Agriculture for the year ended June 30, 1900.

Beginning with the earliest days of the Republic, Government officials, including officers of the Army and Navy and consuls, together with private citizens, interested themselves in importing plants and animals for the general benefit. Congress began to help in 1839 by appropriating $1,000 to be expended by the Commissioner of Patents, after which time the enterprise grew steadily year after year until 1862, when Congress grouped the work along these lines into a Department under a Commissioner. A succession of Commissioners since that time have been instrumental in adding many Old World plants to all localities in our country, and have developed the work along scientific lines as the public demand required. Since 1888 the Department has been in charge of Secretaries who have effected more complete organizations of Bureau and Division staffs. These are now in intimate touch with producers throughout the land.

The present incumbent aims to bring the scientists of the Department to the help of the producers, to ascertain what we import that may be produced in our own country, and to encourage its growth and development; to search the world for grains, fruits, vegetables, grasses, and legumes that may be domesticated here and be an improvement on what we have; to secure new varieties of plants by cross fertilization, that we may by selection establish new hybrids; to cooperate with the experiment stations of the States and Territories in research valuable to the people of the country in all sections; to seek new markets, that our surplus products may bring better rewards to the husbandman.

This Department differs from the others. Appropriations for its use are investments. It makes direct returns by adding to the wealth of the country. It gathers facts and spreads information. Much is added yearly to the profits of our farmers and others as the result of its investigations. Our Weather Bureau has become a necessity to mariners, fruit growers, and others, and, in addition to its services to shipping and commerce, will become still more serviceable to rural communities as free-mail delivery facilities enable us to reach isolated homes more promptly and more frequently.

Our meat inspection insures the public health at home and keeps open doors for us in foreign countries that are satisfied with the excellence of our meats, and have no purpose to serve beyond that.

The orange industry of California and Florida owes its beginning and preservation to this Department. The sugar and tea industries are very promising. Pathological investigations of plants prevent in many localities losses that would otherwise be very serious.

The services of the Entomologist are annually worth more to the people than the total expense of the Department; new industries arise that will dominate our markets, as in the case of the Smyrna fig secured to us because our Entomologist met the fertilizing emergency.

Our tobacco investigations have already given much new light that can not be computed in money values. The same may be said of all our agencies to help producers.

This work will grow and expand from the foundations laid so wisely and well in the past by our farseeing lawmakers until the power of the man and the acre to produce will greatly exceed anything with which we are now familiar, and place within the reach of our rapidly increasing population the necessaries and luxuries of the life that has distinguished us as a people in the past.

A brief summary precedes more extended consideration of the work regularly carried on by the several Bureaus, Divisions, and Offices.

## SUMMARY.

Weather Bureau.—The Weather Bureau is experimenting successfully with wireless telegraphy. Messages have been sent over 50 miles of rough country. The prospect of further improvement is very promising. Storm forecasts have been arranged for the North Atlantic, made possible by location of observers in the West Indies, the Bahamas, Bermuda, and those arranged for from the Azores and Portugal. We have also arranged for observations from Great Britain and France. It is intended to make forecasts for the first three days of outgoing steamers, and the same for those leaving European ports that place themselves in communication with us.

Bureau of Animal Industry.—This Bureau deals with our animals; it inspects meats for interstate and international trade; it inspects pork with the microscope for countries requiring such inspection; it inspects vessels that carry animals to foreign countries, looking to their adaptability; it inspects imported animals to protect our herds; it experiments with swine diseases through serum treatment; it experiments with blackleg in cattle through distribution of vaccine with prospects of eradication, and with sheep scab with like prospects. Rabies exists among dogs and other animals in the District of Columbia and adjoining

States that can be exterminated whenever public sentiment will permit the restraining of dogs from biting for a term sufficient to cover the period of incubation. The Bureau finds that Texas fever among cattle exists in Porto Rico and continues experimentation with dips and other remedies.

*Dairy division.*—Experimental shipments are being made of dairy products across the Atlantic and Pacific and to Cuba and Porto Rico. Complete exhibits were sent to the Paris Exposition. Composition of butter for tropical countries is being studied. Inspection and certification of dairy products designed for export is discussed.

DIVISION OF CHEMISTRY.—The work of this Division has embraced during the year the extent and character of food adulteration; an examination of horse meat; a study of soils; sugar-beet investigations; inquiry into foreign-food products; cooperation with other Departments, with legislative branches of the Government, and with other Divisions of this Department.

DIVISION OF ENTOMOLOGY.—The Smyrna fig is now successfully grown on the Pacific coast as a result of the importation, by this Division, of the insect that fertilizes the blossoms. Over six tons of this fruit were grown and packed the past season. A scientist has prepared a life history of this insect for publication. An African insect has been imported that preys upon the olive scale. A fungous disease of grasshoppers has been imported from Natal that has destroyed swarms of locusts in Colorado and Mississippi.

DIVISION OF BOTANY.—The work of this Division includes testing of seed for Congressional distribution along lines of purity, germination, and trueness to name, the average purity of seeds sent out last year being 97.3 and the average germination 91.4; experiments with home-grown and foreign clover seeds, and methods of seeding land with Bermuda grass; supervision of the introduction of seeds and plants from foreign countries, and distribution among State experiment stations and others making research; investigation of poisonous stock plants and preparation of reports; inquiring into tropical plants of Porto Rico; introduction of Hungarian wheats.

DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY.—The diseases of cereals were studied during the past year; cereals were extensively shown at Paris; plant breeding is a leading feature; orange hybrids have been placed in several Southern localities with a view to hardier trees; corn breeding for earlier maturity, drought, and smut resistance, and increase in protein content is being continued; hybridizing of cottons for longer staples and other improvements is being studied with promising results. This Division cooperates with the Division of Soils in tobacco research; fermentation of tobacco, it finds, results from an agent within the plant. Diseases of the sugar beet are being studied, and also diseases of forest trees.

DIVISION OF POMOLOGY.—The most important work of this Division during the year was that connected with our fruit exhibit at the Paris Exposition, which excelled all other countries in many respects, being continuous from the opening to the close; horticultural implements, seeds, plants, fruits, etc., were shown. Seventeen States were represented in the apple exhibit; the apples were kept in cold storage from the tree to the exposition table. The testing of European grapes was continued during the year. Trees, plants, and vines were extensively distributed to experimenters.

Division of Agrostology.—The study of grasses is essential that the plant may be suited to locality and condition. The grasses are our greatest source of wealth; the Division gathers, studies, and distributes. It cooperates with State experiment stations and producers. The farm and the range are being furnished with plants better adapted to their conditions. In addition to experiments with our native grasses, explorers from the Department search all countries for grasses, legumes, and other forage plants for trial in all sections of our country. Two hundred varieties of grasses have been distributed during the past year and 25 publications have been issued. This Division prepared the exhibit of animal foods for the Paris Exposition, and will have a grass garden at the Pan-American Exposition at Buffalo.

Experimental Gardens and Grounds.—The Department grounds have been brought to their present condition by Mr. William Saunders, deceased. They are now under Mr. Galloway, who will use them as an object lesson, along horticultural lines, for the adornment of the home, in town and country; for a study of nut and fruit trees; for the training of agricultural aids along lines of advanced knowledge in horticulture. The production of American tea is very promising, and capital is now seeking investment in this industry; the labor question is being satisfactorily solved by utilizing colored children.

Biological Survey.—This Division is studying the Belgian hare and what we may expect of it. Congress has given this Department authority regarding the importation of animals from foreign countries, and the Division is in charge of the execution of this law; it is bringing the associations of the States into closer touch regarding the protection of birds. Field work during the year has been carried on in the Pacific coast and contiguous territories in Mexico and British America.

Division of Soils.—Progress in this Division comprises mapping in several States; tobacco investigations, growing Sumatra tobacco under shade, with prospect of saving annually to our citizens, producers and consumers, $15,000,000; experiments in improvement of the aroma of filler tobacco grown in Pennsylvania and Ohio; growing Cuban type of cigar filler in Texas and Porto Rico. The exhibit at Paris was very extensive and satisfactory. In the report expert salaries are discussed and the printing of an annual report of the Division is suggested.

Division of Forestry.—The work of this Division is along the lines of demand for a better knowledge of trees. One hundred and twenty-five people were cooperating during the last year in the study of forestry under the chief of the Division. The Division is cooperating with the lumbermen and tree planters. There is great demand for help from private owners and public custodians; "working plans" are being prepared for both, that is, instructions relative to care and harvesting, to the end that forests be improved and yield returns. Requests for these plans cover over 50,000,000 acres. Private owners of large tracts desire help in this regard as well as States, and those in charge of Government reserves and cities getting waters from wooded watersheds call for help. The effects of clearing off forests is being studied.

Office of Public Road Inquiries.—To systematize and perfect the work of this Office, several expert road engineers have been engaged and assigned to different sections. The special mission of this Department in connection with road matters is to give information and advice as to methods. In several localities sections of roads have been constructed under the supervision of its experts. A laboratory for testing road material has been established under the joint supervision of the Director of the Office and the Chief Chemist of the Department.

Office of Experiment Stations.—This Office is in touch with experiment work in all the States and Territories, and is the medium through which the Divisions of the Department cooperate in research with the experiment stations throughout the land. It inspects all the stations annually, and reports upon their expenditures of national appropriations; cooperation with the stations increases, including work with plants, soils, animals, work in the field, and barn, and in the forest, in irrigation of arid lands, and where there is normal rainfall. The farmers are cooperating in research with this Department and with the several stations, with admitted benefit. Work in Alaska is very promising along lines of garden vegetables, grain growing, and forage curing. This new Territory will get much benefit from growing of green things for home use. Grasses grow there naturally. Cattle can be profitably kept where grasses grow, and mankind lives comfortably where cattle thrive. Reports from agents sent to Hawaii and Porto Rico have been received for transmission to Congress regarding the value of experiment stations in those islands, showing pressing need of research for the benefit of the poorer classes. The nutrition of man is being studied with marked approval of observing people. Home economics are fair fields of scientific inquiry, quite as inviting as the soil, the plant, or the animal.

Section of Foreign Markets.—This Section is engaged in a study of the world's markets. Its mission is to seek an extension in foreign markets of the demand for American agricultural products. Elsewhere will be found a report on the development in recent years of our agricultural export trade gathered from its reports.

Division of Statistics.—Efforts have been put forth to add to the completeness and reliability of the statistics of foreign crops, and arrangements have been made with Hungary and are in course of negotiation with Germany for an interchange, by cable, of agricultural data during the four growing months. Steps will be taken to extend this arrangement to other countries as means at our disposal will justify. Familiarity with conditions during the growth of crops helps toward more intelligent conclusions regarding them at maturity.

Division of Publications.—The work of this Division grows as the Department develops. Seven million copies of publications were printed, and even this number did not meet the demand. Since March 5, 1897, 1,600 different publications have been issued, aggregating 21,000,000 copies, 7,000,000 of which were Farmers' Bulletins. The Yearbook of 1899, with the Paris Exposition edition, has been received with marked favor.

## WEATHER BUREAU.

### WIRELESS TELEGRAPHY FOR THE BENEFIT OF COMMERCE.

Important extensions of the Weather Bureau work have been made during the past year. Recognizing the advantage that would result to commerce and navigation by the establishment of wireless electrical communication between vessels at sea and exposed points on our lake and sea coasts, and also between islands along said coasts and the mainland, the Weather Bureau was directed to systematically investigate the various methods of electrical communication without wires. The progress made is eminently satisfactory. New appliances have been devised for the transmission of signals, and receivers have been constructed that probably are more delicate than any heretofore made. Messages already have been successfully transmitted and received over 50 miles of land, which presented a rough and irregular surface, conditions most unfavorable for the transmission of electro-magnetic waves. It is believed that the efficiency indicated by such transmission overland is sufficient to operate successfully over several hundred miles of water. The apparatus used is capable of further improvement. I hope the time is near at hand when the great number of craft employed in the coastwise commerce of the United States and over its great inland seas will be placed in instantaneous communication with the numerous stations of our Weather Bureau, which are located at all important ports. The matter is one of such great importance to our commerce that I have authorized extensive experimentation, which, from the success so far attending our efforts, will be vigorously prosecuted.

### SPECIAL STORM FORECASTS FOR THE NORTH ATLANTIC OCEAN.

Another important addition to the work of the Weather Bureau in the near future will be the beginning of special storm forecasts for the North Atlantic Ocean, a step made possible both by the use of the reports received from the West Indies, the Bahamas, Bermuda, and those to be received from the Azores and Portugal through the new cable system connecting Lisbon, the Azores, and New York City. Arrangements already have been made by which daily observations will be received from Great Britain and France. The transoceanic and coastwise commerce of the several nations will doubtless receive as much benefit from this extension of the weather service as the commerce of the Caribbean Sea, the Gulf of Mexico, and our South Atlantic cities has received as a result of the action of the United States in extending its meteorologic reporting stations over all the important islands of the West Indies. It is intended to make forecasts of wind force and wind direction for the first three days of the route of all outgoing steamers, and for an equal period for such as place themselves in communication with the Weather Bureau before leaving European ports. We view with satisfaction the consummation of an object so long sought by both the meteorologist and the mariner.

### VALUE OF THE FORECAST SERVICE.

No effort has been spared to improve and strengthen the forecast service. The value of the West India meteorological service inaugurated in 1898 has several times been demonstrated, notably in the case of the hurricane that devastated Galveston. This storm was detected at its inception on September 1. Its location was daily platted and its course and intensity successfully forecast for eight days before it reached the Texas coast, during which time it traveled about 2,000 miles. Storm warnings again were successfully displayed in advance of this storm before it reached the Lake region. It is a significant fact that, notwithstanding the great number of craft plying the Gulf of Mexico and our inland seas, the warnings were so timely that there was no disaster upon the open waters.

## BUREAU OF ANIMAL INDUSTRY.

### MEAT INSPECTION.

In the general meat inspection much time has been devoted to improving the system and perfecting checks to guard against the use by unscrupulous dealers of meat which has been condemned as unwholesome. The law which is intended to guard against this fraud is not as stringent or perfect as is desirable, and it requires constant vigilance on the part of the inspectors to accomplish the object of the inspection.

The number of localities where the work of meat inspection was in operation during the year was increased from 41 to 45, while the number of abattoirs and packing houses receiving the benefit of this inspection was 148, as against 138 in the preceding year.

On account of the lessened demand in Continental Europe for American pork, due probably in part at least to the increase in price in our home markets, there has been a reduction in the amount of microscopic inspection.

The total ante-mortem inspections of cattle aggregated 53,087,994, including those for official abattoirs in cities where inspections were made, for abattoirs in other cities, and for miscellaneous buyers. The number of animals rejected, subject to results of a post-mortem inspection, was, at abattoirs, 5,958, and in stock yards, 153,561.

The numbers and classes of animals inspected at time of slaughter, and the number of these or parts thereof condemned, will be found in the following table:

*Post-mortem inspection for fiscal year 1899.*

| Kind of animal. | Number of inspections. | | | Carcasses condemned. | | | Parts of carcasses condemned at abattoirs. |
|---|---|---|---|---|---|---|---|
| | For official abattoirs. | On animals rejected in stock yards. | Total. | For official abattoirs. | Animals rejected in stock yards. | Total. | |
| Cattle | 4,841,166 | 20,828 | 4,861,994 | 6,209 | 4,029 | 10,238 | 8,973 |
| Sheep | 6,119,886 | 5,209 | 6,125,095 | 4,234 | 1,240 | 5,474 | 309 |
| Calves | 315,693 | 276 | 315,969 | 182 | 54 | 236 | 32 |
| Hogs | 23,336,884 | 92,112 | 23,428,996 | 38,598 | 7,248 | 45,846 | 21,032 |
| Horses | 5,559 | | 5,559 | 112 | | 112 | |
| Total | 34,619,188 | 118,425 | 34,737,613 | 49,335 | 12,571 | 61,906 | 30,346 |

The meat-inspection tag or brand was placed upon 17,177,442 quarters, 343,427 pieces, and 1,554 sacks of beef, 6,050,444 carcasses of sheep, 310,126 carcasses of calves, 1,138,507 carcasses of hogs, and 653,756 sacks and 48,485 pieces of pork.

The ordinary meat-inspection stamp was affixed to 5,584,995 packages containing beef, 24,151 of mutton, 107 of veal, 13,122,677 of pork, and 602 of horseflesh.

Seals were attached to 69,937 cars containing inspected products.

The number of ordinary certificates issued, except for horseflesh, was 43,631. The meat products covered by these certificates aggregated a total weight of 438,138,233 pounds of beef, 680,897 pounds of mutton, and 272,050,663 pounds of pork. Eight certificates were issued for 188,800 pounds of horseflesh.

The cost of conducting the work of ordinary meat inspection was $505,280.52, an increase of $39,571.29 over the amount expended the previous year.

### MICROSCOPIC INSPECTION OF PORK.

The number of carcasses examined was 999,554, resulting in the following classification: Class A, free from all appearance of trichinæ, 968,405, or 96.88 per cent; Class B, containing trichina-like bodies or disintegrating trichinæ, 11,701, or 1.17 per cent; Class C, containing living trichinæ, 19,448, or 1.95 per cent.

The number of certificates issued for 253,333 packages bearing the microscopic inspection stamp was 12,107; these packages had a weight of 55,809,626 pounds.

The year witnessed a great falling off in the trade in microscopically inspected pork products. The cost of this inspection was $154,950.22; average per carcass, 15.5 cents; per pound exported, 0.277 cent. For 1899 the cost was $198,355.14.

### INSPECTION OF VESSELS AND EXPORT ANIMALS.

While there has been an increase in the total exports of cattle to all countries for 1900 over 1899, the decline in the number of domestic cattle and sheep exported to Europe, noted in the last report, has continued; but there has been an increase in the number of horses over last year of 40 per cent. The figures for Canadian shipments from American ports show a decrease in all classes of animals.

The total number of inspections made of animals for export was: Cattle, 656,164; sheep, 163,267; horses, 56,315. The number rejected was: Cattle, 1,391; sheep, 117; horses, 174.

The number of clearances given to vessels carrying live stock, after inspection by officers of the Bureau and having been found suitably equipped in accordance with the regulations of this Department, was 862.

The number of American and Canadian animals inspected at port of debarkation by inspectors of this Department stationed at London, Liverpool, and Glasgow, together with the number and percentage lost in transit, is shown in the following table:

| From— | Cattle. | | | Sheep. | | | Horses. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Landed. | Lost. | | Landed. | Lost. | | Landed. | Lost. | |
| | *No.* | *No.* | *Per ct.* | *No.* | *No.* | *Per ct.* | *No.* | *No.* | *Per ct.* |
| United States | 290,609 | 556 | 0.19 | 71,547 | 436 | 0.61 | 27,836 | 741 | 2.59 |
| Canada | 19,889 | 189 | .94 | 24,997 | 253 | 1.00 | 1,228 | 20 | 1.60 |
| Total | 310,498 | 745 | .24 | 96,544 | 689 | .71 | 29,064 | 761 | 2.55 |

### INSPECTION OF IMPORTED ANIMALS.

The numbers and classes of animals imported from Mexico and inspected at ports of entry along the international boundary line are here given: Cattle, 80,329; sheep, 9,976; swine, 44; goats, 4,132; horses, 3.

From Canada the imports of animals not subject to detention at quarantine stations comprised 77,693 cattle, 209,373 sheep, 1,886 horses, 1,092 swine, 6 goats, and 1 deer—total, 290,051. Of these, 1,012 cattle, 7,262 sheep, 137 horses, and 180 swine were imported for breeding purposes.

Through the port of New York there were imported 265 horses and 350 mules; through the port of San Francisco, 8 horses.

During the quarantine season of 1899 the Bureau supervised the movement of 1,058,484 cattle from the district infected with the Southern cattle tick (*Boophilus bovis*), and 39,663 cars were cleaned and disinfected. In Texas 357,422 cattle were inspected for shipment or trail to other sections.

The sheep industry has greatly suffered from sheep scab, and this Department has given much time and attention to securing its control and eradication. It has been a difficult matter to get control of the sheep traffic in such a manner as to prevent the spread of scab without at the same time too seriously interfering with the marketing of the animals. To lessen the burden of the sheep owners as much as possible, the regulations were at first very simple and easily complied with; they have been made more stringent and effectual as the nature and objects of the requirements became known.

The effect of this work has been very marked. Sheep owners have been encouraged and stimulated to treat their diseased animals and free their ranges from the contagion. There is a much smaller number of diseased sheep found in the stock yards, and the infection is gradually disappearing. A few years more of earnest work will be sufficient to eradicate this disease and to remove in this manner one of the greatest sources of loss to the sheep industry.

The number of sheep inspected at various places was 1,801,379, and 626,838 were dipped under the supervision of Bureau inspectors.

### SERUM FOR HOG CHOLERA AND SWINE PLAGUE.

The work of preparing serum for treating hog cholera and swine plague has been continued. Inspectors of the Bureau have been engaged in treating a large number of animals in two counties in Iowa, two of the same counties in which work was conducted during the previous year. The results in general, so far as can be determined at the present time, will not justify definite conclusions, but are sufficiently encouraging to justify continued experimentation, including some experiments on entirely new lines.

The preparation of the large quantities of antitoxic serum necessary to conduct this work in the field has entailed a large amount of routine work in the laboratory, and also at the experiment station, where the animals for supplying the serum have been treated. Full reports are being kept this year, as last, of the herds that are treated. Cultures are taken from the sick animals and are sent to the laboratory for further tests and identification, and care is taken not only to demonstrate the exact character of the disease so far as possible existing in the animals which are treated in the field, but also to test the quantity and character of the serum used for treatment. Important variations in cultures, cultural products, and their bearings which have developed in this work are being carefully studied.

### THE PREPARATION AND DISTRIBUTION OF BLACKLEG VACCINE.

During the past fiscal year 1,076,060 doses of blackleg vaccine have been prepared and distributed among the various States and Territories, as itemized below. The demand for this preventive is steadily increasing, and the summarized reports of 2,000 cattle owners testify to the great efficiency of the preparation in reducing losses from blackleg to a minimum. It is conservatively estimated that the annual loss from this disease when no preventive measures are taken amounts to about $6,000,000. This estimate is based upon the reported loss of from 10 to 25 per cent of all young stock in the vast districts of this country where blackleg prevails.

So far as can be judged at the present time the loss after vaccination during the past year has been less than one-half of 1 per cent.

Since the beginning of the distribution of blackleg vaccine in August, 1897, the total number of doses furnished to the cattle raisers of this country amounts to 1,711,900, and the indications are that between 2,000,000 and 2,500,000 doses will be required to supply the demand during the fiscal year ending June 30, 1901.

The distribution for the year covered by the present report included thirty-seven States and three Territories.

The biochemic division has made and distributed 10,722 doses of mallein for testing horses for glanders. The greatest part of this was supplied to the War Department, while small amounts were distributed in twelve different States. It has also made and supplied to State authorities 33,400 doses of tuberculin to be used for testing cattle for tuberculosis.

## THE PREVENTION OF TUBERCULOSIS.

Tuberculosis is the most prevalent and most destructive disease affecting mankind and the domesticated animals. Among farm stock, cattle and swine are most often affected. During the last twenty years there appears to have been a great increase of animal tuberculosis in the principal countries of Europe, and unfortunately in those countries from which our breeders desire to obtain animals for the improvement of their stock.

While this disease exists in parts of the United States, it is yet limited as to territory, and even in the worst infected districts there is a much smaller proportion of the cattle and swine affected than is found in European countries.

Modern investigations show that tuberculosis is produced by a specific germ, the *Bacillus tuberculosis*, and that this disease can not develop until the body is invaded by this germ, which can only come from some diseased individual, either man or animal. Being a strictly contagious disease and arising only by contagion it is important for our stock interests that the law prohibiting the importation of diseased animals should be strictly enforced.

Until the last year reliance has been placed upon the ordinary physical examination of imported cattle while in the quarantine stations.

Experience has shown, however, that this examination even by the most skillful inspectors is not reliable. Accordingly, the tuberculin test has recently been adopted, and it is hoped that with this more accurate means of diagnosis the American farmer may be protected from further importations of this contagion.

As the loss of a considerable proportion of high-bred cattle after they have been purchased and brought to this country would be a severe burden to importers, it has been decided to station an inspector in Great Britain to test and certify to the animals before shipment. By adopting this method diseased animals may be excluded at the time of purchase and the traffic in healthy animals will proceed with less risk than heretofore. Similar arrangements have been made for testing Canadian cattle.

Numerous restrictions have been placed upon the interstate shipments of breeding and dairy cattle by the individual States, in order to guard against the introduction of diseased animals. The hardships and burdens thus put upon the legitimate traffic in healthy animals which are carried in the channels of interstate commerce leads to the suggestion that uniform regulations under federal authority may save our shippers much annoyance and loss, and at the same time furnish protection from disease.

The authorities of several States have requested this Department to take action which would prevent the interstate shipment of tuberculous animals, but it is doubtful if existing law authorizes the measures required for efficient control, and anything short of this would prove an additional burden without bringing the desired relief.

## DANGER FROM RABIES.

It is unfortunate that the disease known as rabies, canine madness, or hydrophobia is apparently on the increase in the United States. A considerable number of outbreaks have come to the attention of Department officials during the past year, and these have been so widely separated as to indicate an extensive distribution of the contagion. While dogs are most frequently affected, cattle and horses are not uncommon victims, and a single mad dog running through a herd of such animals may cause losses of hundreds or thousands of dollars' worth of property.

One of these outbreaks of rabies occurred during the year in the District of Columbia, extending into adjoining portions of Maryland and Virginia, and was very carefully studied by the Bureau of Animal Industry. Between July 1, 1899, and June 30, 1900, the disease was demonstrated by the most careful laboratory tests in 45 dogs, 1 cat, 4 cows, and 1 horse. Other cases occurred which were not submitted to this critical scientific study. Four men and sixteen children were bitten by these rabid animals.

For various reasons the local authorities have not in most cases efficiently controlled these outbreaks of rabies. In the District of Columbia, under federal laws and administration, the disease has existed for a year and has not yet disappeared. In some States its presence has scarcely attracted official attention.

As this is one of the most terrible and fatal of diseases, as it is communicable to man and to most or all species of warm-blooded animals, it is extremely desirable that the contagion should be eradicated. That this can be accomplished without extraordinary efforts is clearly shown by the recent experience of Great Britain and other countries.

The continued existence of the disease at the national capital is a subject for regret, and shows a lack of efficient measures for protecting human and animal life. On account of the number of persons, particularly children, which have been bitten, and the serious burden and expense to families in moderate circumstances to send their children to other cities for the Pasteur treatment, I would recommend that the Secretary of Agriculture be authorized to pay for such treatment out of the appropriation for the Bureau of Animal Industry in all cases where the parties have been bitten in the District of Columbia, or that one of the medical services of the Government which maintains a laboratory at the capital be directed to furnish this treatment free of charge.

It appears that some additional legislation is needed to enable this Department to prevent the interstate extension and distribution of this dreaded disease.

### THE EXPERIMENT STATION.

The experiment station of the Bureau has proved of great service. The antitoxin animals during the year supplied about 1,500,000 cubic centimeters of blood for use in the biochemic laboratory in making hog cholera serum. A serum for the prevention of tetanus or lockjaw is being prepared and will soon be ready for use.

### TEXAS FEVER.

The work on Texas fever has been of two kinds: First, that directly concerning the disease; and, second, that concerning the destruction of the Southern cattle tick.

It has been found by recent experiment that the Texas fever exists in the island of Porto Rico, and very probably in other portions of the West Indies. The ticks received from Porto Rico and used in our experiments are identical with the well-known Southern cattle tick.

The main problem of the Texas fever question remains as last year—the finding of a dip that will effectually destroy the ticks without affecting the cattle injuriously. The great benefits to be derived from the solution of this problem will justify the expenditure of considerable time and money in our efforts to solve it, and further experiments will be carried on with unabated energy and the added light derived from past experience. It is thought possible that something may be done by combining a dip with a drench containing substances which will act on the tick through the secretions of the skin of the cattle.

### THE DAIRY DIVISION.

During the year a detailed report was prepared upon the series of experimental shipments of dairy products to European markets, which were made under special authority given in the acts of Congress making annual appropriation for this Department.

In the latter part of the year experimental shipments to Europe were again inaugurated, special efforts being made in connection with the Department exhibit at the Paris Exposition to show the high quality of our dairy products.

A number of experimental shipments of butter, cheese, and cream have also been forwarded to trans-Pacific points, which had been visited and selected by a special agent of the Department. On account of the great distance and the failure of some of the consignees to at first fully understand the purposes of the Department's efforts, it is not yet possible to make a report upon these shipments.

Arrangements were made in the dairy division for the United States exhibit of animal industries at the Paris Exposition. The chief of the division took personal charge of the preparation of the various exhibits.

Much valuable information concerning dairying in foreign countries has been received in reports from consuls, through the courtesy of the State Department. These reports will be prepared for publication as soon as the work of the division permits.

Shipments of butter to Cuba and Porto Rico have been begun. In these experiments we are confronted with problems quite similar to those met in the shipments from San Francisco to the Orient. The dairy products are forwarded to warm countries, shipment has to be made without refrigeration, and cold storage is not available at the points of destination. It is necessary, therefore, to send butter, and perhaps cheese, as well as condensed milk and cream, in hermetically sealed packages, which afford the best means known of preserving such perishable products. The Department is seeking to obtain information useful to butter exporters in canning butter and producing butter which has a hard body. To this end, experiments are now in progress at some of the State stations. Some countries sending butter in cans to the new markets supply a product with a very high melting point, showing in this, as in other ways, a disposition to adapt their products to the needs of those countries, an example our producers must follow if they are to successfully compete in those markets.

The experimental shipments of the dairy division will be directed to showing our producers what they have to do in this respect.

It is proposed to ascertain the prospects for trade in dairy products in the South American countries besides those already named.

### INSPECTION OF DAIRY PRODUCTS.

It is considered extremely desirable that the existing system of Government inspection and certification of meats and meat products for export be extended, by additional legislation, so as to include butter, cheese, and condensed milk and cream for export from the United States. Reasons for such legislation have been stated in previous reports, and they apply now even more forcefully than when first given. Briefly, a few of the arguments for such new legislation are as follows:

Foreign buyers of dairy products have so often been deceived by misleading, and sometimes false statements, claiming that shipments of dairy products are high grade when really they are inferior, or in part inferior, that many of them suspect all products exported from this country, and avoid them whenever it is possible to supply their needs elsewhere. In this way we have recently lost a fine market in Great Britain for our cheese.

The Department has expended much labor and money to establish a reputation abroad for American dairy products, and already the good results accomplished are being counteracted by the shipment of inferior goods which are claimed to be of high quality. After the buyers on the other side have been defrauded a few times by such shipments they will be unwilling to deal with us when it can be avoided.

Other countries have developed large foreign trade in their dairy products, and it is well known that one of the principal reasons for their rapid advance in the largest markets of the world is the fact that their best products are marked with a Government stamp, showing conclusively that the article is as represented.

The proposition of inspecting dairy products for export has been indorsed by nearly all of the large conventions of representative dairymen in this country, and it has the decided approval of commercial bodies and individual exporters. So far as I am aware, no objection to it has been made.

## DIVISION OF CHEMISTRY.

### FOOD ADULTERATION.

The Division of Chemistry has continued, during the past year, its elaborate work in the investigation of the extent and character of food adulteration and the composition of foods. The principal study during the year has been of the composition and adulteration of preserved meats, a subject in which the whole country has lately taken particular interest. In all, 513 samples have been purchased in the open market, consisting of preserved meats of all kinds, including soups and potted meats.

An examination of the meat of the horse has also been carried out, 39 samples having been purchased and analyzed with the object of determining a method whereby horse meat could be easily detected if sold under any other name. In so far as can be discovered, this meat is not offered for sale in any part of the United States under its own name, and it is believed that very little of it is sold under any other name.

The Division has during the year been engaged in active cooperation with other organized bodies, notably the Pure-Food Congress of the United States, to promote the effort to secure State and national legislation on the subject of food adulteration. In quite a number of the States the laws which have been passed have been modeled upon the Brosius pure-food bill, which is now pending before Congress, and which, by its passage, would secure a perfect control of interstate traffic in adulterated foods. It is only by such national legislation that the excellent work which the States are doing in controlling State legislation can be properly supplemented and made efficient. Every consideration of honesty and justice to the producer and consumer demands that Congress should take early and favorable action upon the pure-food bill which is now pending.

### SOIL BACTERIA.

The studies of soil bacteria have been continued, with results which are of the most encouraging nature in regard to practical agriculture. The studies of the relation of the crop to the composition of the soil have also been continued, completing a term of five years, which covers a sufficiently long period to warrant the tabulation and publication of the results already secured.

### SUGAR-BEET INVESTIGATIONS.

The chemical work attending the sugar-beet investigations has been pursued with vigor during the past year, and comparative data have been collected from all parts of the United States relating to the influence of soil and climate on the character of the beet produced. These investigations have already led to a tentative mapping out of the areas of the United States suited to beet culture, and their continuance will enable intending investors to locate definitely in those areas most favorable to the production of the highest quality of beets.

It is only by careful attention to these scientific details that the beet-sugar industry in this country can hope to compete with the carefully controlled industry in Europe.

### THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

The patronage of the Department of Agriculture has, through the Division of Chemistry, been continued to this official body, representing the chemists employed in the agricultural experiment stations and colleges and in State and municipal bodies having control of food products. The practical effects of the work of this organization have been most favorable to the advancement of our agricultural interests, and also to securing, both at home and abroad, a proper recognition of the valuable work of our agricultural chemists. There is no other country in the world where agricultural chemical investigations are pursued on so large a scale as in this country, and, through the organization of our chemical workers, we are securing a dominant influence in the agricultural chemical councils of the world. This influence has been recognized by the successive international congresses of applied chemistry, held at Paris in 1896, at Vienna in 1898, and again at Paris in 1900.

### EXAMINATION OF FOREIGN FOOD PRODUCTS.

The study of the character of foreign food products introduced into this country has been prosecuted with vigor during the past year. The results of this study are of a confidential nature, and are used for the information of the proper authorities of this country in the control of imported food products.

### COOPERATION WITH EXECUTIVE DEPARTMENTS.

At the request of the heads of Executive Departments, the Division of Chemistry has continued its extensive cooperation with those Departments during the past year.

For the War Department tests have been made of the chemical and physical properties of the cloth intended for the manufacture of uniforms for soldiers in the Tropics, and on the results of these analyses the contracts for the cloth were concluded.

Numerous analyses of food materials have also been made at the request of the Secretary of War for the guidance of the ration board in selecting materials for an appropriate emergency ration for the Army.

Analytical investigations have also been conducted during the year for the Departments of State and of Justice, the Post-Office and Navy Departments, and for the U. S. Fish Commission.

Collaboration with the Treasury Department in connection with the methods of collecting duties on imported sugars has been continued, and the Chief Chemist gave more than a month of his time to the work during the year. The principle of the method of correcting polariscopic readings for the effect of temperature, which has been adopted by the Treasury Department for fixing duties on sugar, and which the investigations of the Division of Chemistry have shown to be rigidly correct, has been approved by the international committee appointed to determine uniform methods of sugar analysis. This committee, at its meeting in Paris in July, 1900, recommended that in all countries polariscopes employed should be graduated for the temperature at which they are to be used. This is an unqualified approval by the highest international authority of the methods of sugar analysis established as correct by the investigations of the Division of Chemistry of this Department.

### COOPERATION WITH THE LEGISLATIVE BRANCHES OF THE GOVERNMENT.

During the past year, at the request of the chairman of the Senate Committee on Manufactures, I directed the chief of the Division of Chemistry to cooperate in every possible way with this committee in the investigation which it was making in regard to the adulteration of foods. The results of these investigations have been published in the report of the committee already submitted to the Senate of the United States.

### COOPERATION WITH THE DIVISIONS OF THIS DEPARTMENT.

The cooperative work with the several branches of the Department of Agriculture has been continued in several directions.

For the Bureau of Animal Industry a study of dairy products, especially of butters of different origin, has been conducted. Particular attention has been paid to the detection of so-called "process" butter and its chemical and physical peculiarities. A study of the composition of foreign cheeses has also been made, both from the point of view of adulteration and of food value.

In connection with the Division of Soils, collaborative work on soil analysis has been conducted, and working room for one of the chemists of that Division has been provided.

The Division of Entomology has assisted the Division of Chemistry in collecting samples of insecticides, and a number of analyses have been made at the request of the Entomologist.

Determinations of the water content of indian corn and other cereals have been made at the request of the Division of Botany. In turn, the vitality tests of the beet seeds distributed to various parts of the country, and also of the seeds used in connection with the soil experiments of the Division of Chemistry, were made in the seed laboratory of the Division of Botany.

Rooms have been provided the Division of Forestry for clerical and other work, and preliminary arrangements have been made for extensive chemical investigations of trees and bark.

I directed the Division of Chemistry to make an investigation of the methods of testing road materials for the Office of Public Road Inquiries of the Department. The laboratories at Johns Hopkins and Harvard universities were visited, and the machinery and processes in vogue studied. As a result of these investigations, I have established in the Division of Chemistry a laboratory for the study of good road materials, in order to determine what materials or what mixtures of materials are best suited to road making.

### MISCELLANEOUS WORK.

The Division of Chemistry, in addition to the above outline of its investigations, has charge of a large quantity of miscellaneous work bearing directly and indirectly upon agricultural subjects. This work includes the analysis of raw and manufactured fertilizers, waters intended for irrigation or for watering stock, soils of miscellaneous origin, whose examination can not be secured in the State agricultural experiment stations, and many other analyses of a character incapable of classification.

As will be seen from the above report, the work of the Division of Chemistry touches almost every branch of agriculture and every department of the Governmental service.

## DIVISION OF ENTOMOLOGY.

### IMPORTATION OF BENEFICIAL INSECTS.

In my last Report I referred to the important work being done under the direction of the Entomologist in the importation and establishment of the insect which fertilizes the Smyrna fig. This insect was successfully carried through the winter, and during the summer it has been cared for with such good results that in one locality in California more than 6 tons of Smyrna figs of the highest grade of excellence have been produced and packed. Down to the present year the Smyrna fig has had a practical monopoly of the dried-fig market of the world. None had been successfully grown in America. The direct result of the importation and establishment of this insect will be to make America a strong competitor in the dried-fig trade in the world's markets. Other beneficial insects have been introduced into the United States. An important parasite has been imported from Africa, which preys upon the olive scale, an insect very injurious to the olive groves in California. A fungous disease of grasshoppers has been introduced from Natal, which has destroyed injurious swarms of locusts in Colorado and Mississippi. The Entomologist is endeavoring to introduce European parasites of the gipsy moth. It is hoped they will be effective against this injurious species, on which the State of Massachusetts has ceased to make war.

### WORK AGAINST INJURIOUS INSECTS.

Important work has been done against insects damaging forests in the far Northwest and in the woods of Maine. Experimental work has been carried on against the scale insects injurious to fruit trees and against insects affecting garden crops.

Further work has been done on the Hessian fly, the codling moth of the Northwest, toward the exact delimitation of the permanent breeding grounds of the migratory grasshoppers of the Northwest, and on the geographic distribution of the injurious insects of the United States.

### PUBLICATIONS ON MOSQUITOES.

The recent publications of this Division on the subject of mosquitoes have been greeted by medical men of this country with decided approval. Physicians are shown how to distinguish the mosquitoes which are responsible for the spreading of malaria from those that do not carry the malarial parasites, and there is also pointed out the means by which certain neighborhoods can be freed of mosquitoes and consequently of malaria.

### WORK ON BIBLIOGRAPHY AND BEE CULTURE.

Work has been conducted on the bibliography of American economic entomology, as well as experimental work along much-needed lines of investigation in bee culture.

## DIVISION OF BOTANY.

### SEED TESTING.

As the mandate of Congress has laid upon the Department of Agriculture the work of purchasing and distributing larger amounts of seed than ever before, the duty of carrying out this task in an effective manner has become still more imperative than formerly. For several years past the Division of Botany, by my direction, has tested the seeds of the Congressional distribution to ascertain their mechanical purity and germination. The importance of these tests will be appreciated when it is known that the average mechanical purity of the seeds distributed last year was 97.3. The average germination of the same seeds was 91.4. These averages I consider indicate the high character of the seeds in the Congressional distribution, so far as mechanical purity and germination are concerned. It has been alleged, however, that while the seeds distributed by the Department were of highly creditable germination and mechanical purity, they were deficient in purity of stock, genuineness, or trueness to name. Tests to ascertain the validity of these allegations were therefore inaugurated.

These tests show that the average purity of stock last year was 86.7 per cent. Therefore, although the extent of this defect has been greatly exaggerated by those opposed to the policy of seed distribution, there is nevertheless sufficient reason to warrant me in taking steps to effect a remedy. I have therefore established the following standard for purity of stock:

The standard of trueness to name for each variety shall be the average of the percentage of trueness to name in not less than five commercial samples of the same variety purchased under the direction of the Secretary of Agriculture in the open market from five or more reliable seed houses, and the Secretary of Agriculture shall be the sole judge of the results of the tests reported by the officer or officers charged therewith by him. Not less than 100 plants from each lot of the seeds furnished by the contractor shall constitute a test.

The maintenance of the high standards for seeds distributed at the direction of Congress will place these seeds above reproach. There is, however, another improvement which I propose to inaugurate in the Congressional distribution. The Department has maintained for some years past a trial ground, in which it has made comparative tests of the standard varieties of vegetables, and also of many of the novelties which are placed on the market by American seedsmen. These experiments have shown that each year there are offered new varieties of established superiority, which the Department without difficulty can secure and distribute. By proper handling, these novelties can be purchased at prices little if at all higher than those of the common varieties heretofore included in the Congressional distribution. Furthermore, it will be remembered that three years ago, with the permission of Congress, I set apart from the seed appropriation a fund to be devoted to the introduction of new and valuable seeds and plants from foreign countries. The plants thus introduced have been tested by the various State experiment stations, by properly qualified private experimenters, and by the Department itself, most of our own experiments having been conducted on the Potomac Flats testing grounds, placed at our disposal two years ago by authority of Congress and by permission of the Secretary of War.

Several plants thus introduced have, as heretofore reported, demonstrated their capacity of increasing the agricultural products of our country by millions of dollars annually. Some of these seeds should be very widely distributed. It should, therefore, be the policy of the Department to introduce into the Congressional seed distribution new varieties of established superiority developed in the United States or imported from foreign countries, to distribute these varieties for one or more years until they have been sufficiently brought to the attention of the people, and then to discontinue their distribution, leaving the demand thus created to be supplied through the ordinary commercial channels. In this way the Department will be enabled to carry out the original intent of the seed-distribution law, will furnish seeds of the highest character, and will avoid the evil of competition with the regular seed trade.

### PLANTS POISONOUS TO STOCK.

Early last winter an urgent request was received from Hon. T. C. Power, chairman of the State Board of Sheep Commissioners of Montana, that the Department investigate the poisonous plants of the great stock ranges of that State, which annually cause the death of thousands of sheep and other stock. In response to this request, two experts in poisonous plants were sent to Montana. It was ascertained first what the plants are that have caused the losses of stock, and means of preventing these losses were then devised, both through the avoidance of the poisonous plants and through the application of remedies to animals that have already been poisoned. An illustrated report of this investigation will be completed early in the coming winter.

### ECONOMIC PLANTS OF THE TROPICS.

In my last Report I pointed out the desirability of securing at an early date, both for the education of the people and for the use of those intending to enter the field of tropical agriculture, some reliable information on the useful and agricultural plants of the Tropics, and although little money was available for this purpose, a fully illustrated report on the useful plants of Porto Rico has been prepared. In this report special attention has been paid to india rubber, coffee, and other tropical plants, regarding which the Department has received the most numerous inquiries. In my estimates for the next year's appropriations I have included an item for the prosecution of this special line of botanical inquiry. It is intended that this work shall occupy a ground intermediate between that of the technical botanist on the one hand and the actual agricultural experimenter and tropical farmer on the other, and to furnish information which will be indispensable to these classes, but which it would be impossible for them to acquire without great expense of time or money.

### EXPERIMENTS ON THE POTOMAC FLATS.

Two years ago Congress authorized the temporary use of a portion of the Potomac Flats as a testing ground for the Department of Agriculture. During the season of 1898 an area of 25 acres was fenced, cleared, and put in shape for the reception of crops, and this year the actual experimentation began. Among the many experiments carried on there, I desire to call attention to two, either of which has more than repaid the entire cost of maintaining the grounds. I refer to an experiment in the germination of Bermuda grass seed, and another in relation to foreign and American clover seed. Bermuda grass is one of the most valuable grasses known in the Southern States. It has been very difficult, however, to get a good stand from seed, and Southern farmers in starting a field of this grass have been compelled to go through the laborious process of setting out roots. Tested Bermuda grass seed sent out from the Department last year was reported a failure by experimenters in the South. Seed showing the same test was sowed on the flats under varying conditions, and a remarkable stand has been secured. It appears from this year's trials that for good results the seed of Bermuda grass must be sowed at such a season as to insure surface moisture for a period of several weeks during the time of germination and early growth. This points to the practice of fall or winter sowing in the Southern States. If further experimentation shall confirm this preliminary conclusion, the result will be a large saving to Southern farmers and a wide extension of the use of this valuable grass.

On the subject of red clover seed there has been an active controversy in Europe, particularly on the Continent. In some years this seed is exported in enormous quantities from the United States, the value of the export in a single year having reached the sum of nearly $5,000,000. Upon the allegation that American clover seed contained a large percentage of weed seeds a careful investigation of this point was made, which showed that such a position was untenable. This is now conceded by many of the European seed-control stations. Next the allegation was made that the American clovers produced a crop different and inferior in character from that of the European clover. On this point different seed-control stations of Europe have taken opposite sides. The Department has also interested itself in the subject, and last year secured many authentic samples of European-grown and American-grown clover seed. The comparative tests of these on the Potomac Flats strongly indicate that, whatever may be the ultimate result of the European investigation in regard to the relative merits of red clovers for cultivation on that Continent, so far as the clover-growing parts of the United States are concerned, American seeds are decidedly the more valuable. This is likely to have an important bearing on the clover-seed market in years of shortage of the American crop, when clover seed is sometimes imported from abroad.

## SECTION OF SEED AND PLANT INTRODUCTION.

The Section of Seed and Plant Introduction was instituted to bring into this country for experimental purposes any foreign seeds and plants which might give promise of increasing the value and variety of our agricultural resources. So far, its work has been eminently satisfactory, and, in the fuller development of its results, there is promise of almost incalculable benefits to American agriculture. Of the varieties introduced in the past four years, many have proven commercially successful and many others show favorable indications so far as they have been tried. The newly introduced seeds and plants are distributed for testing purposes mainly to the State experiment stations and to a small number of private experimenters. No general distribution is attempted until the value of the new varieties is established. Among the most valuable importations made, the following may be mentioned:

### SOME VALUABLE IMPORTATIONS.

CEREALS.—Russian and Hungarian wheats, superior in yield, milling qualities, and resistance to rust, have been introduced and tested; also white wheats from Australia, Europe, and the Orient to replace the white wheat of California, which has shown a tendency to deteriorate. The so-called macaroni wheats from southern Europe are succeeding so well in the Great Plains as to warrant the establishment of the macaroni-manufacturing industry. Valuable new varieties of oats, rye, barley, and buckwheat have also been introduced.

GRASSES AND FORAGE PLANTS.—The smooth brome grass (*Bromus inermis*) from Hungary has proven an extremely valuable pasture grass, and is already quite widely distributed throughout the Middle West. Turkestan alfalfa has proven superior in hardiness and drought resistance, and is therefore an especially valuable addition to the leguminous crops which can be grown in our semiarid regions. Superior varieties of soy beans have been brought from Japan, and several other forage plants of lesser importance have proven desirable acquisitions.

VEGETABLES.—In this class may be mentioned some very fine varieties of muskmelon from Russia which have succeeded in Colorado and other Rocky Mountain States, squashes from Italy, a new radish from Japan, the silver-ribbed chard, a superior variety of eggplant, and a French variety of edible-podded peas.

FIGS AND DATES.—The Smyrna fig industry, the introduction of which had been so often attempted without success, now appears to be established in California. The securing for Arizona of date trees true to name is another valuable accomplishment which will be slower in reaching results, but the next generation will count this one of the greatest agencies for the development of the warmer portions of the arid Southwest.

RICE.—While the rice industry of the South, and especially of Louisiana and Texas, has grown rapidly in recent years, the introduction of the Kiushu rice from Japan was necessary to lift it to a position among the great cereal crops of the country. Of this rice, Dr. S. A.

Knapp, of Louisiana, who procured the original importation in 1898, reports as follows:

This year has thoroughly proved the superiority of the Kiushu rice in every way. Under favorable conditions, the yield is on an average fully 30 per cent more than that of Honduras or South Carolina (the ordinary varieties). Under unfavorable conditions Kiushu rice yields from 100 to 400 per cent more than any other rice. It yielded this year 4 or 5 barrels per acre without any water except rain. The Honduras rice grown under the same conditions produced nothing. The straw is so tough that the seeds will not whip off in a storm. It mills 30 to 50 per cent more head rice (unbroken grains) than the Honduras. The Department never spent money that helped the country more than that spent in the importation of this Japanese rice. It has brought about the opening up and development of an extensive region in southwestern Louisiana and southeastern Texas, where the land was not previously of any value except for cattle grazing. It has resulted in the investment of probably $20,000,000. It has increased the production of rice in Louisiana more than $1,000,000 per annum. Rice now has a future in the United States second only to wheat.

### VALUE OF SEED AND PLANT INTRODUCTION.

That the value of seed and plant introduction to the agriculture of the United States is very great, all who are familiar with its results must agree. It would be impossible for anyone to estimate in dollars the benefits already derived, much less the vastly greater benefits which will come with the future. It is safe to say that in many instances the introduction of a single new variety will be worth more to the country than the whole cost of the work done by this Section. It would, indeed, be within bounds to estimate the value of some single introductions as exceeding the annual cost of the Department. The value of the Smyrna fig industry to California, it is estimated, will not be less than $1,000,000 annually. The value of the introduction of Kiushu rice will certainly not be less, and probably far more, than that of the Smyrna fig industry.

But the most valuable of all is the introduction of superior varieties of wheat from Russia, Hungary, Australia, and elsewhere. In many cases these new wheats are reported to exceed in yield the varieties they are displacing by 5 bushels or more per acre. The area in wheat in the United States in 1899 was over 44,000,000 acres; now, if by the introduction of better varieties, the average yield is increased only 1 bushel per acre, we will have an increase of 44,000,000 bushels, worth at the farm price for 1899 (nearly 60 cents per bushel) about $26,000,000. These figures will at least give an idea of the possibilities involved in this work.

## DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY.

As now organized, the Division of Vegetable Physiology and Pathology consists of five branches, or laboratories, namely, plant pathology, plant physiology, Pacific coast investigations, plant breeding, and plant nutrition and fermentation. Each branch is in charge of an assistant, who is responsible for the main details connected with his particular line of work. The division of labor effected by this arrangement has led to excellent results, responsibilities being placed where they should rest, and each man being led to take special interest in developing his field.

### CEREAL WORK AND CEREALS AT THE PARIS EXPOSITION.

During the year special attention was given to the study of cereals, their diseases being investigated and a number of new lines of work inaugurated. The most important work, however, consisted in the collection and installation of a commercial cereal exhibit at the Paris Exposition. This work was planned to give the world some idea of the enormous resources of the United States in the matter of grain and grain production. Every effort was put forth to make the exhibit as striking as possible, and its effect on our commercial relations with other countries was kept in mind throughout the entire work. The exhibits of only a few countries, such as Canada, Russia, and Hungary, compared well with the exhibit of the United States as regards quality of grain, and only those of Canada, France, and Hungary compared at all with our exhibit in both quality and variety.

An excellent opportunity was afforded for showing our wonderful capacity in the production of dent corn. Not only was the entire corn collections from other countries small as compared with ours, but they were composed almost entirely of flint varieties. In all the work special emphasis was placed on leading export varieties of wheat, corn, and other cereals, the number of separate exhibits entered being about 1,500. Appreciation of the work of the United States was generously manifested by the numerous awards in class 39, which included cereals. The exhibit unquestionably aided in bringing the resources of this country as regards grain production into prominent notice, and also served as a valuable means of gaining knowledge as to the possibilities of other countries in this direction.

### PLANT BREEDING.

The plant-breeding work was pushed forward as rapidly as possible, mainly along lines similar to those upon which work was conducted last year. The orange hybrids, made with a view of securing hardier sorts, have been placed at various points in the South, and cooperative experiments have been inaugurated at several experiment stations to test the value of these hybrids. The work in corn breeding, begun in 1899, was continued and considerably extended. The features of importance aimed at in connection with this work are early maturity, drought resistance, resistance to smut, increased protein content, and increased yield. Important work was inaugurated in the South for the purpose of improving varieties of cotton. Special efforts were made to obtain by breeding and selection races of cotton with a longer and finer staple than that of the ordinary upland sorts. Already promising results have been obtained in this direction, and it is believed that varieties can be secured which will be of great value in a number of important cotton-growing districts.

### COOPERATION IN TOBACCO INVESTIGATIONS.

The cooperative work with the Division of Soils on tobacco, started two years ago, was continued. As a result of the work, it has been found that the true cause of fermentation is not bacteria, as formerly supposed, but chemical ferments produced by the tobacco plant itself. This discovery has suggested important modifications of the old methods of handling tobacco, which promise much improvement in Northern cigar leaf tobacco. The practical application of the results of these investigations will unquestionably be the means of adding millions of dollars to the wealth of the country. Unfortunately, the specialist who was engaged by the Government to carry on this work was led to sever his connection with the Department by the very flattering inducements offered him by a foreign country. In addition to the work on the fermentation of tobacco, much attention was given to a study of diseases of this crop, and some results were obtained which will go far toward bringing about methods of prevention.

### SUGAR-BEET DISEASES.

The growing importance of the sugar beet in this country has called attention to a number of very serious diseases which have prevailed, especially during the past year. One of these diseases attracted widespread attention in California, where it caused an estimated loss of over $2,000,000. Every effort was made to obtain as much information as possible in regard to the trouble, but owing to limited funds it was not practicable to undertake a thorough study of the matter.

### DISEASES OF FOREST TREES.

Special work on the diseases of forest trees was inaugurated and carried on in cooperation with the Division of Forestry and the Shaw School of Botany of St. Louis. The special agent in charge of this work is instructor in botany in the Shaw School and has excellent facilities for carrying on the investigations. The rapidly growing interest in forestry problems has created a widespread demand for information as to diseases affecting trees, and in recognition of this fact the work has been pushed forward as rapidly as possible.

### CHANGES AMONG THE OFFICERS OF THE DIVISION.

The affiliation of this Division with three other Divisions in the Department, referred to elsewhere in this Report, made some changes among the officers necessary. Mr. B. T. Galloway, for thirteen years chief of the Division, having been made Director of Plant Industry, Mr. Albert F. Woods, who had been assistant chief for the past seven years, has succeeded him at the head of this Division.

## DIVISION OF POMOLOGY.

### THE PARIS EXPOSITION EXHIBIT.

The most important new work undertaken by the Division of Pomology during the year was the collection, preparation, and installation of the horticultural exhibit at the Paris Exposition. As this was the first attempt to make a comprehensive exhibit of American horticulture and horticultural products at a foreign exposition, it was regarded as most desirable that the showing should be worthy of that great industry. The results attending this exhibit were such that I am convinced that the fruit industry of this country will be greatly benefited by this notable display of American horticulture and horticultural products, which was maintained throughout the entire time of the exposition.

The exhibit consisted of horticultural implements, seeds, plants, illustrations, etc. As fruit culture is generally recognized as the largest and most important feature of American horticulture, special prominence was given to it by maintaining a continuous fresh-fruit exhibit from May 9 to the close of the exposition. Seventeen States were represented in the apples exhibited, and the California exposition commissioner furnished the oranges. The apples were shipped in refrigerator compartments, and when they reached Havre, the seaport of Paris, they were again placed in cold storage, being taken in installments to the exposition tables as needed. The fruit was in excellent condition when unpacked, and furnished conclusive proof of the practicability of prolonging the marketing season. The exhibit attracted wide attention, and the ultimate effect, I am sure, will be an increased foreign demand for American products.

No other country attempted to maintain a continuous fruit exhibit, even the French section being bare of fruit during at least two-thirds of the time.

### CULTURE OF EUROPEAN GRAPES.

The effort to give a thorough test to the culture of choice European grapes in the South Atlantic States was continued during the year and with the promise of ultimate success. It now becomes important to make a careful study of the varieties under cultivation. Happily we may determine methods of pruning, cultivating, fertilizing, and combating disease which will render the production of these valuable fruits in this country quite satisfactory.

### CATALOGUE OF FRUITS AND COOPERATIVE WORK.

The card catalogue of fruits described in standard American publications has been finished, and so soon as all the fruits can be catalogued, will afford copy for the most complete index in pomology.

Cooperative work with the Section of Seed and Plant Introduction, Division of Botany, in the distribution of fruit-bearing trees, plants, and vines was continued during the year. Over 700 lots have been placed with about 125 experimenters, and 200 varieties, representing 22 species, have been thus distributed.

## DIVISION OF AGROSTOLOGY.

### CLASSIFICATION OF DIVISION WORK.

The growth in the work of this Division has necessitated reorganization, and it has been divided into four sections, each under the charge of a specially qualified assistant. These sections are: First, experimental, which has charge of all experimental operations carried on outside of Washington, D. C., in cooperation with the State experiment stations; second, seed and field, which has charge of the collection of seeds, roots, and specimens, and useful native grasses and forage plants, and the distributing of the same, as well as the making of field studies with these plants in various parts of the country; third, grass garden, which includes the care and maintenance of grass gardens and experiments in the District of Columbia; fourth, the herbarium section, in charge of the collections of the Division and the naming of material or specimens sent in for identification. These sections also prepare reports and bulletins along their various lines of work. The investigation of animal foods was also assigned to this Division by Congress at its last session, but as no appropriations were made for conducting this work, it has not been taken up. This organization or classification of the Division work has increased its effectiveness along all lines, but especially in the field investigations and experiments.

### COOPERATIVE EXPERIMENTAL WORK.

The work in Texas, which has been carried on in cooperation with the citizens of Abilene, in that State, was originally designed to demonstrate the possibility of improving the worn-out cattle ranges and pastures by practical methods. The grazing of pastures has been so improved as the result of experiments conducted by the Division that pastures which three years ago were estimated by experts to be capable of supporting only one steer to 16 acres will now maintain in good condition one steer to 8 acres, a net gain of 100 per cent in the carrying capacity. The possibility of growing clovers, and especially the improved varieties of alfalfa, in this section of Texas has also been determined by the experiments of our agent at Abilene. The work carried on at Wallawalla, in cooperation with the Oregon Railroad and Navigation Company, has been devoted exclusively this season to the production of seed of important native grasses and forage plants for distribution to the agricultural experiment stations.

Arrangements are now made for continuing, through this Division, seed production in cooperation with experiment stations, and the work at Wallawalla will close with the present season. The station at Highmore, S. Dak., conducted in cooperation with the State experiment station, has been continued, and the results of the season's work there will form the subject of a divisional report. The work of last season was set forth in Circular No. 21 of this Division. These experiments have attracted a great deal of attention from ranchers and farmers, and already they are beginning to put into practice the methods recommended for improving the ranges which have been shown to be so efficacious at the stations named. Among the questions which will be taken up in these cooperative investigations are the following: Range improvement; the formation and management of meadows and pastures; forage plants for alkali soils; sand-binding and soil-binding grasses; soiling crops for a continuous series throughout the season; winter pasturage; the relation of forage crops to the reclamation of worn-out lands and the maintenance of soil fertility; selection and development of varieties of grass and forage plants adapted to special purposes or conditions, or possessing special qualities of hardiness, palatability, yield, etc.

The investigation of forage crops suitable for alkali soils will be undertaken with the Montana and Colorado experiment stations and with the stations in other States in which there is a large amount of such land. The question of sand-binding and soil-binding grasses is of special importance at certain points on the Pacific coast, along the Great Lakes, and on the Atlantic coast, and it is planned to undertake investigations of such grasses in connection with the Oregon experiment station, and perhaps with other stations in the regions represented. Experiments with soiling crops are being carried on with the Maryland experiment station, and these will be extended to other sections where dairying is a leading industry and where this question is an important one. Winter pasturage is one of the most vital questions for the South, and its investigation is accordingly being arranged with certain of the

Southern experiment stations, while with others the study of forage crops and their relation to the improvement of the fertility of the soil, another question of importance in this section, will be undertaken. Similar investigations are being planned for the New England States. The study of selected varieties of grass and forage crops is a question of general importance throughout the country, and investigations are being carried on in cooperation with the Division of Vegetable Physiology and Pathology and with such of the State experiment stations as are prepared to undertake the work.

During the past three years there have been distributed through the Division of Agrostology seeds of 250 varieties of grasses and forage plants, nearly all of which had never before been cultivated; 5,000 packages were sent to volunteer experimenters on farms and ranches, 3,000 to State experiment stations, and over 1,100 to stations in foreign countries. Reports from the volunteer experimenters to whom this seed was sent were published in Bulletin No. 22 of the Division. As a result of the extensive distribution of the seed of Turkestan alfalfa through this Division and through the Section of Seed and Plant Introduction, Division of Botany, much useful information concerning this crop has been secured and was presented in Circular No. 25 of this Division.

These cooperative investigations form the most important part of the work of the Division, and Congress, at its last session, by a clause in the appropriation bill, made it imperative that this work be carried on in cooperation with the State experiment stations. With a view to carrying out this work in accordance with the law, nearly all the State experiment stations were visited by the officers of the Division and arrangements made for carrying on cooperative experiments. The work has been carefully and effectively organized, and articles of cooperation have been signed by the directors of ten of the agricultural experiment stations jointly with the Agrostologist, and approved by me. The plans proposed have met with the most cordial reception on the part of the station authorities, and it is already manifest that this work of the Department, thus carried on through the experiment stations, will have greater efficiency and assure more definite results of greater value to the farmers and stock raisers of the country than was possible by the methods previously employed. The individual and volunteer experimenter, moreover, can accomplish much through suggestions and aid furnished by the Division, and can carry the work into sections which can not be reached in any other way; the intelligent farmer or ranchman who is willing to devote land and labor to the propagation of new grasses and forage plants furnished by the Division is a valuable factor in developing the work of the Department and carrying it directly before the people.

## FIELD WORK.

The field work of the Division has been conducted during the past season as heretofore, but particular attention has been devoted to collecting seeds, roots, and specimens of valuable native grasses and forage plants, as especially provided for by the last session of Congress. This work has been carried on in Oregon, Arizona, Colorado, Montana, New Mexico, Wyoming, Michigan, Idaho, Minnesota, Maine, the Carolinas, Georgia, and Florida. Several tons of seed have been gathered in this way, which will be distributed to the different State experiment stations for further seed production and experimental cultivation. In cooperation with an official of the State experiment station of California, explorations have been made in the northern part of that State, and a report has been prepared for publication on the forage resources of northern California as a result of these field investigations. Aside from the collection of seeds, attention was directed in these field investigations to the study of the native grasses and their suitability for use in range improvement, investigations of drought-resistant forage plants, sand and soil binders, forage crops suitable for the reclamation of worn-out lands and winter pasturage, and grasses adapted for use in the making of lawns or grassing of pleasure grounds.

## GRASS GARDENS.

The grass garden on the Department grounds, which contains nearly 500 varieties of grasses, has been continued and has afforded many valuable lessons relative to these plants. An important feature of the garden has been the testing of various saltbushes and legumes and also the different varieties of grasses used for lawns. The space allotted to this work on the Department grounds has been so limited that the area devoted to any individual species was very small. To remedy this and give opportunity for more extended cultivation, especially for the large and coarse-growing annuals, an area of land on what is known as the Potomac Flats was set aside for the work, and here it has been carried on very successfully during the past season. The results obtained here with some of the native grasses and legumes from the Southwest have been remarkable, and the possibilities of successful culture of many foreign species has been demonstrated.

## DISTRIBUTION OF SEEDS AND SPECIMENS.

Seeds of some 200 varieties of grasses in 3,000 packages have been distributed, chiefly to experiment stations and correspondents in the United States. Nearly 5,000 herbarium specimens of grasses and a large number of sample sheaves for exhibition purposes have been distributed during the year.

### PUBLICATIONS.

During the year the Division has issued 25 publications, covering a wide range of subjects along lines of the work of the Division, both practical and scientific, and there has been large demand for them both from scientists and farmers.

### THE HERBARIUM.

The already large collection of grasses and forage plants has been increased by the addition of more than 5,000 sheets of mounted specimens, which have been collected by the agents of the Division or deposited by the National Herbarium, and specimens obtained by purchase or received in exchange from foreign countries. Nearly 4,000 determinations of specimens for correspondents have been made during the year.

### PARIS EXPOSITION EXHIBIT.

To this Division was assigned the preparation of the United States exhibit of foods for animals. These were divided into two classes: First, seeds of grasses and forage crops offered in the markets, stock foods, oil cakes made directly from various cereal crops or as by-products in the manufacture of sugar, cotton-seed oil, linseed oil, and other commodities; second, the exhibit of the more important grasses and forage plants grown in this country, with samples of seed of both native and introduced varieties, together with a large collection of photographs illustrating the habits of growth of the different sorts and the methods of cultivating, harvesting, and utilizing them. This exhibit has called forth many favorable comments both at home and abroad, and was recognized by the commission of awards with a number of grand prizes and medals, both to the Department and to individual exhibitors.

### PAN-AMERICAN EXPOSITION.

During the Pan-American Exposition to be made at Buffalo next season the Division will maintain a grass garden upon the grounds for exhibiting the various native grasses and forage plants or those of special value for lawns, binding soils, drifting sands, etc. A feature of this exhibit will be the exhibition of sand-binding grasses on an artificial sand dune, which has already been planted. The ground for this garden has been put in condition, and nearly all the seeds and roots have been sown or planted. In addition, there will be an exhibition of grasses in the form of sheaves or panels and photographs, similar to those used to illustrate the work of the Division at the Paris Exposition.

### FUTURE WORK.

The future work, as now planned, will be the supervision and execution of the cooperative investigations with the experiment stations, which, during the coming year, will consume a large part of the time and resources of the Division. The field work will be carried into regions that have not hitherto been studied. The routine and office work of the Division will be carried on as indicated above under the present plan of organization. Preliminary arrangements are being made for undertaking experiments in methods of destroying Johnson and other noxious grasses, but until appropriations are made for this new line of work little can be done. Each year the importance of the field work is becoming more and more manifest, one of its useful purposes being the bringing of the work of the Division before farmers and ranchmen and others interested in the various parts of the country. The extensive plans now made for carrying on the work in cooperation with the experiment stations will demand close supervision of experts in the lines of work contemplated and necessitate considerable increase in the Division force.

## EXPERIMENTAL GARDENS AND GROUNDS.

The Experimental Gardens and Grounds comprise about 35 acres, and ever since the organization of the Department they have been in charge of Mr. William Saunders. Mr. Saunders died on September 11 of this year at the age of 78 years. He was a man of sterling integrity, and during his long and useful life labored constantly to advance the cause of agriculture in all of its branches. The Gardens and Grounds have been placed in charge of Mr. B. T. Galloway, who since 1887 has been chief of the Division of Vegetable Physiology and Pathology.

### FUTURE WORK.

The future work of the Gardens and Grounds will be along broad horticultural lines. The grounds will be used as an object lesson for encouraging the adornment of the home and also for a study of the problems which will lead to the making of the farm home more attractive. Close cooperation will be effected with other Divisions in the Department, and every facility will be afforded them to strengthen their work. A study of nuts, fruits, and other horticultural crops will be undertaken with a view of disseminating the rarer and more promising sorts, and determining the conditions best suited to their growth. Special attention will be given to the encouragement of new horticultural industries and the advancement of knowledge along these lines in cooperation with the present experiment stations and those that may be established in Porto Rico and Hawaii. Opportunities will be afforded in this work and that undertaken in cooperation with the other Divisions of the Department engaged upon plant industrial investigations for the training of scientific aids along broad horticultural lines. For the constantly increasing work of the Department and that of the experiment stations men with broad training will be needed, and it is hoped that the Department can aid in making more such men available.

## TEA PRODUCTION IN THE UNITED STATES.

In my last Report attention was called to the efforts being made by the Department in the production of tea. For several years Dr. Charles U. Shepard, a public-spirited citizen of Summerville, S. C., has been experimenting with a view of obtaining information as to the practicability of producing American tea, and his efforts promised so much of value that it seemed proper for the Department to render assistance in certain directions. To this end arrangements were made with Dr. Shepard whereby certain machinery, etc., were to be furnished in order to settle some questions pertaining to the commercial production of tea. Throughout the work the question of labor has been an important one; but through Dr. Shepard's efforts there has been adopted a method for utilizing the labor of colored children. What Dr. Shepard has accomplished in this matter in his region could undoubtedly be brought about in other sections of the South, where much idle labor is awaiting proper utilization. Dr. Shepard has established schools on his place, and in these the children are received and educated, and at the same time are taught to pluck tea and perform other work in connection with the production of the crop. For such work fair wages are paid, and in this way interest is maintained.

The experiments so far conducted have shown that tea may be produced in the United States in two ways: (1) By families in their gardens, as was demonstrated years ago to be entirely feasible; and, (2) on a commercial scale, after the manner followed by the British East Indian tea establishments and the beet-sugar industry.

The work at Summerville was started with a view of ascertaining whether under favorable conditions tea plantations could be made to yield as much as the average oriental production, and whether the crop could be marketed at a fair profit. The results obtained have been affirmative, the crop of 1900, although not so large as expected early in the season, exceeding that of any previous year by at least 12 per cent, and the entire product being sold before it was all gathered to a prominent Northern distributing house at a price that gave a fair profit.

As further evidence that tea can be profitably grown in the United States, capitalists are already making preparations to begin the work in certain parts of the South on a more or less extensive scale. A company with a capital of $50,000 is being organized, and will endeavor to secure a location having soil and climatic conditions adapted to the growth of tea, and where labor, such as Dr. Shepard utilizes, can be secured.

From what has already been accomplished, it has been shown that a good grade of tea can be grown and put on the market in bulk at a cost not exceeding 15 cents per pound. Under average conditions an acre will yield 400 pounds of marketable tea, and this, at 15 cents per pound, would make the expense of growing it $60 per acre. The tea should sell in bulk for at least 30 cents per pound, and the profit on this basis would be 100 per cent. Besides the cost of marketing, however, there are other expenses to be considered, namely, the salary of a superintendent and the interest of the money invested in the plant, which would, of course, cut down the profits.

From the foregoing, it seems that the commercial possibilities of tea production in this country can no longer be questioned, but there are still many points to be settled, especially as regards the improvement of the product. During the past year experiments have been undertaken for the purpose of determining the effect of irrigation on tea and of shading the plants from the direct rays of the sun. Work has also been inaugurated with a view of reducing the cost of the preparation of tea, especially the green tea. The experiments in irrigating and shading, which will be continued, have given promising results, the shaded plants giving nearly double the yield of the unshaded, and a much finer grade of leaf.

In the future special attention will be given to the manufacture of pure green tea. This subject is now claiming the attention of both inventors and planters in the British colonies, as they begin to realize the hopelessness of bringing American tea drinkers to use the black tea instead of the green. The manufacture of green tea in the United States can be made successful only by the invention of machinery which shall take the place of expensive hand labor and prevent the waste which accompanies the latter. These questions are all being investigated by the Department and, in addition, it is giving special attention to a study of the conditions in various parts of the South with reference to determining the localities where tea can be grown to best advantage. Experiments have been inaugurated by some of the experiment stations and plants distributed with a view of putting the work on a substantial basis. Much need is felt for young men capable of taking up this important problem, and it would be well for the agricultural colleges of the South to bear this matter in mind.

## DIVISION OF BIOLOGICAL SURVEY.

### FIELD WORK.

Field work was carried on in California, Texas, New Mexico, Alaska, Mexico, British Columbia, Manitoba, and the Northwest Territories. The outlining of life zones in California was continued in the Coast Range and carried south to the Bay of San Francisco, under the personal direction of the chief of the Division. During the present season a careful examination will be made of that part of the Sierra Nevada lying between Sierra Valley and the Yosemite, including the region about Tahoe, Donner, Independence, and Webber Lakes.

In Texas special attention was given to the collection of data for most accurately outlining the life zones in the southern half of the State, and more particularly in the region along the Gulf coast from Corpus Christi to Brownsville and west to the Rio Grande below Laredo. A preliminary investigation of the most economical methods of destroying prairie dogs was also undertaken. In view of the damage caused by this pest not only in Texas, but also in several other States in the arid region of the West, the destruction of these animals is a practical question of great interest to many farmers and worthy of thorough investigation by the Department.

### THE BELGIAN HARE.

Much interest in the Belgian hare has been developed during the last three years, especially in California, Colorado, and other Western States. But however valuable Belgian hares may be for meat or fur, their introduction in large numbers is accompanied by a certain element of danger which should not be overlooked. Some are sure to escape, and the State Board of Horticulture of California has estimated that several thousand of the animals are already at large in the State. If they increase as rapidly when at large as they do in captivity, they will undoubtedly become a source of danger, and stringent measures may be required to keep them under control. Still more dangerous would be the introduction of the Belgian hare into Porto Rico, where the question of its acclimatization has already excited interest.

### STUDY OF FOOD OF BIRDS AND BIRD PROTECTION.

Laboratory and field studies of the food of birds, especially of species of economic importance, have received much attention. The object of these investigations is to obtain reliable information which will enable the farmer to distinguish between species which are beneficial and those which are injurious to his crops. Such knowledge naturally creates a desire to increase the abundance of useful species, and it is very gratifying to note the widespread and constantly increasing popular interest in bird protection.

With a view to bringing the various associations concerned with the protection of birds into closer touch with one another, a list of the State officials, national organizations, State game associations, and various Audubon societies was published in the Yearbook of the Department for 1899. Still further to meet the demand for information regarding the protection of birds, a compilation was made of the laws now in force in each State in the Union, so far as they relate to birds other than game.

### THE LACEY ACT.

A short time before the close of the year I assigned to this Division all matters relating to the importation and preservation of birds contemplated by the act of Congress known as the Lacey Act, which went into effect May 25, 1900. This act gives the Department large powers and responsibilities, and the object, as expressed in the first section, is, "To aid in the restoration of such (game and other wild) birds in those parts of the United States adapted thereto where the same have become scarce or extinct, and also to regulate the introduction of American or foreign birds or animals in localities where they have not heretofore existed." In my last Annual Report attention was called to the necessity for legislation restricting the introduction of noxious animals and birds from abroad, and I am gratified to report that in the Lacey Act Congress has absolutely prohibited the importation of the English sparrow, mongoose, starling, flying fox, and such other species as may be declared injurious to agriculture, and has also prohibited the shipment of such species from one State to another. It is believed that this law will afford the United States greater protection against the introduction of injurious animals and birds than is enjoyed by any other country.

Congress has also authorized the Secretary of Agriculture to adopt such measures as may be necessary to carry out the purposes of the act, to collect and publish useful information on the propagation, uses, and preservation of birds, and to purchase game and other birds, subject to the laws of the various States and Territories. Under my direction all necessary steps to carry the law into effect have been taken by the Division, so far as this is possible in the absence of a specific appropriation. The present appropriations of the Division being inadequate, I earnestly recommend an increase which will not only enable the regular investigations already under way to be carried on more effectively, but will permit the enforcement of the provisions of the Lacey Act as the importance of the work and public interest in it seem to demand.

## DIVISION OF SOILS.

### PROGRESS OF SOIL SURVEY.

The Division of Soils has continued and considerably extended the investigation and mapping of the soils of some of the important agricultural districts of the United States. This work has been carried on during the fiscal year in Connecticut, Pennsylvania, Maryland, North Carolina, Louisiana, Utah, California, and Arizona. The total area surveyed and mapped (on a scale of 1 inch to the mile) amounts to 3,386 square miles, or 2,160,000 acres. The Report of the Field Operations of the Division of Soils for 1899, which was transmitted to Congress by the President on February 5, 1900, has been published with the accompanying maps and illustrations. There has been an unprecedented demand for this publication, and the number assigned for the use of this Department has been heavily drawn upon to supply Senators, Representatives, and Delegates, who found their quotas entirely inadequate to supply the demands.

The pressure for the soil survey work has been so great from many districts that the limited means at our disposal and the few trained men available to head the field parties have made it necessary to shift the parties in the field more than would otherwise have been advisable. Foreseeing the popular demand there would be for work of this character, I have caused a number of young men to be trained in the field and laboratory work, so as to be ready to meet the demands should Congress see fit to increase the appropriations. Since the importance and practical value of the work have been appreciated, and especially since the published reports and soil maps have appeared, the pressure from all parts of the country has been so great that I have asked Congress for an increase of $80,000 in the appropriation for this soil survey work. If this be granted work will be immediately started in about twenty States and Territories, assigning one field party to each of these States for an entire field season of from six to nine months. Each one of these parties should survey from 600 to 1,000 square miles per year and prepare soil maps for the use of farmers and others interested in the development of our agricultural districts.

The Department has received many letters and resolutions from various individuals and organized associations speaking in the highest terms of the practical value of the maps and reports, indorsing the accuracy of the work so far done, and urging in the strongest terms that similar work be instituted in a number of other localities.

The reports of the field operations of the Division of Soils can not from the nature of things be confined to 100 printed pages, which is the statutory limitation imposed upon the Secretary for editions exceeding 1,000 copies. As the popular demand for the work is very great and is increasing, and as the publication of the reports, illustrations, and soil maps is expensive, I recommend that Congress make provision for the publication of an annual report of the field operations of the Division of Soils—as is now done with the Annual Report of the Chief of the Weather Bureau and with the Annual Report of the Chief of the Bureau of Animal Industry—through an amendment to the printing bill providing for the publication of 30,000 copies, 10,000 of which to be placed at the disposal of the Secretary of Agriculture, and the rest to be distributed through Senators, Representatives, and Delegates.

The details of the soil-survey work, together with the physical and chemical investigations done in support of this, are given in the report of the chief of the Division of Soils.

### TOBACCO INVESTIGATIONS.

Several years ago, as a result of the soil investigations in the Connecticut Valley by this Department, a prediction was made that the Sumatra type of tobacco could be grown there. After some preliminary experiments in the summer of 1899 some Sumatra tobacco was planted under shade in the spring of 1900, the experiments being under the direction of the Division of Soils cooperating with the Connecticut experiment station. The leaf produced has been so fine that the New York tobacco men say that it can not be told from the imported Sumatra leaf. They predict as a result of this work a complete revolution in the tobacco industry of the Connecticut Valley and the substitution of Sumatra tobacco, as has already been done in the State of Florida. We import into this country, in spite of the high import duty of $1.85 per pound upon wrapper leaf, about 40,000 bales of Sumatra tobacco, which, with the duty added, costs about $15,000,000, of which nearly $6,000,000 are annually paid to foreign producers. It is believed that in a very short time we will be able to save this to pay our own producers.

Experiments are now being made in the improvement of the flavor and aroma of the filler tobacco of Pennsylvania and Ohio. It is believed that with the introduction of the methods of fermentation now being tried in Pennsylvania that the saving in that State alone from case rot will amount to at least $1,000,000 annually. Furthermore, it is reasonable to hope that the aroma and flavor of the present crop can be improved, which will greatly enhance the value of the product.

This tobacco work has been so eminently practical and so successful that it has received the hearty support of the tobacco men. Not only the growers, but the leaf tobacco associations and the large tobacco dealers, are urging us to continue and to considerably extend the investigations. I should like very much, in addition to the present work, to foster the interest in Texas, where I believe the Cuban type of cigar filler can be successfully grown, and in Porto Rico, where the methods are crude and where I believe a much finer product can be produced than is now grown.

Business men and private corporations pay salaries from $4,000 to $6,000 to managers of tobacco estates, and it is not possible for the Department to get efficient men for much less than this sum. Such salaries for tobacco experts are not to be considered, however, while the chief of the Division, who directs and coordinates the work, has a statutory salary of only $2,500. Already one expert has left to accept service at a salary over four times as much as the Department was paying him. The tobacco men are demanding that if the work be continued and extended it must be by men in whom they have thorough confidence and who are well fitted by experience to carry on the work. Such men can not be retained by the Department except for salaries commensurate with what private corporations are paying. As the Department is concerning itself more and more with these large commercial interests, in order that the work shall conform to a high standard and be of the greatest practical value we must pay as much for experienced men as they can get elsewhere.

### TOBACCO EXHIBIT AT THE PARIS EXPOSITION.

The tobacco exhibit at Paris was one of the largest and most complete exhibits which has ever been made. It contained over 2,000 samples, representing all the commercial types and grades of tobacco produced in this country, including the various export types and our domestic manufacturing and cigar types. Two very important points came out in the awards of the jury. The Florida-grown Sumatra tobacco was awarded 20 points of merit against 18 points for the tobacco submitted from the island of Sumatra, and the Florida-grown leaf was admittedly a thinner leaf with much more elasticity. It took twenty-five more leaves in the 16-inch size to make a pound of the domestic than of the foreign-grown leaf. This is a matter for congratulation, and will undoubtedly secure a name and a market for the Florida product, which, on account of the prejudice for foreign-grown products, it would have been difficult to secure for the Florida crop. The bright yellow tobacco of North Carolina was awarded the same number of points as the Turkish tobacco with which it came into competition.

While it was admitted that the Turkish tobacco had a more desirable aroma, the North Carolina product, besides closely approximating this, has a larger leaf, which can be used for wrappers as well as for fillers for all tobacco cigarettes and plug. It costs much less to produce and is altogether more of a general-purpose tobacco, and is therefore more desirable. Foreign countries are appreciating this fact, and our exportations, especially to Great Britain and Japan, have increased enormously in the past few years. There is reason to believe that the desirable Turkish aroma may be imparted to our own product without detracting in any way from the other desirable qualities which it admittedly possesses. The tobacco exhibit was altogether a very creditable display for this country, and it is believed that it will be a very good thing for our commercial interests. The tobacco men express themselves as thoroughly satisfied with the work the Department has done in presenting our products at the exposition.

## DIVISION OF FORESTRY.

### GROWTH OF THE FORESTRY WORK.

The work of the Division of Forestry continues to be thoroughly practical and direct. While the principal lines of effort remain unchanged since my last Annual Report, the work itself has taken on a somewhat new and larger character with its growth. During the past summer its total membership at the highest was about 125, and this large increase in numbers, which, thanks to the small pay of collaborators and student assistants, does not involve a proportionate increase in expenditure, has necessarily been accompanied by a considerable expansion of the working organization. It may be of interest to note here that during the past two years the working force of this Division has increased about three times faster than its appropriations. There has been, too, a parallel gain in system and efficiency, and the Division of Forestry is now in a more effective condition than at any time in the past. I am particularly glad to report that its relations with practical lumbermen and tree planters were closer and more useful during the past year than ever before. It has done work of a kind which fully justifies the proposal to give it additional resources, and I have taken occasion in my estimates to recommend a considerable increase in the appropriation for its use. I was led to do so not merely by the record of the Division, but also by the enormous increase in the demand, both public and private, for its services in all parts of the United States. These demands were last year far beyond the power of the Division of Forestry to meet, and the appropriation was accordingly increased. But while the appropriation was a little less than doubled, the demand for working plans, the most important of the four sections of this Division's work, increased during the past year not less than twenty-five times.

### THE DEMANDS UPON THE DIVISION.

The insistent demand for the services of the Division of Forestry is the most conspicuous fact to be noted here, and the inability of the Forester, through lack of resources, to meet these demands is perhaps the most serious of all hindrances to the progress of practical forestry in this country. Public interest in forest matters is just now not only keener and wider than at any time heretofore, but it is growing with a rapidity altogether without precedent. To fail to use this unequaled opportunity for the protection and preservation of our forests would, I believe, be of the nature of a real misfortune.

Until the past year the requests which came to this Department for working plans originated altogether from private sources, and they were, as I have said, far more numerous than the resources of the Division of Forestry could meet. During the past year not only have the requests from private owners of forest lands continued in undiminished number, but the work of the Division in this direction has been recognized by official requests covering enormous areas of forest land. The most important of these came from the Secretary of the Interior in the form of an application for working plans for the whole area of the national forest reserves. This first step toward the introduction of the principles of forestry on Government forest land was heartily seconded by this Department, and in spite of the fact that the Department of the Interior was unable to bear any share of the expenses, preliminary examinations of several reserves were undertaken, and the preparation of a working plan for the Black Hills Forest Reserve was begun in the very early spring. This working plan was pushed forward vigorously during the summer, completed as to field work in the late autumn, and will be entirely finished during the coming winter. It will give complete and explicit directions for the harvesting of the forest crop in the Black Hills in such a way as to perpetuate the supply of native timber, without which the enormous mining interests of this section must suffer most severely.

The second official request came from the Forest, Fish, and Game Commission of New York in the form of an application for working plans for the whole area of the New York State Forest Preserve—about a million and a quarter acres in extent. Work was begun in June on township 40, which includes Raquette Lake, and the completed working plan will be submitted to the commission before the close of the present calendar year.

The total requests for working plans amounted, at the end of the last fiscal year, to 51,192,714 acres, of which about two and a half million acres are for private lands. It should be noted that all of the working plans hitherto put in operation by the Division of Forestry have been continued, in most cases under greatly improved circumstances, and in no case with any loss of efficiency. In addition to the official work above noted, personal examinations were made during the year of 48 tracts in fourteen States, covering 878,670 acres; working plans were prepared for 200,000 acres, and 50,000 acres were put under management.

## COOPERATIVE WORK.

One of the largest manufacturers of agricultural machinery has applied for a working plan for the tract from which his timber is to come, and in cooperation with the Division of Forestry extensive technical forest work has been for the first time undertaken by a lumber company in the South.

Practical cooperation with tree planters has been greatly extended during the year. Field work began in September, 1899, and from that time until the close of the fiscal year planting plans were made for 59 applicants. The work extended from New York to California, and from North Dakota to Texas, but it centered in the States of the plains, where the necessity for wood lots, wind-breaks, and shelter belts is very great. Studies of the natural encroachment of trees upon the plains were conducted in connection with the cooperative tree planting, and considerable numbers of public meetings have been held by the agents of the Division engaged in tree-planting work. Careful studies and measurements of the results of plantations already made have formed one of the most useful parts of the work of the section of economic tree planting, which is also engaged in a wholly unique investigation of the relation of forest cover to the flow of streams in southern California. Through the courtesy of Mr. H. B. Hedges, engineer of the Arrowhead Reservoir Company, observations of precipitation, run-off, evaporation, and temperature, made with complete thoroughness and accuracy for a period of eight years, were placed at the disposal of the Division, and strong hopes are entertained of valuable results from the comparison of the run-off from various types of cover. This Division is, with increasing frequency, receiving applications for planting and working plans for watersheds from which cities obtain their supplies. A typical instance is that of the water company of Johnstown, Pa., where one of the chief objects in view is to assist in preventing the possibility of a recurrence of the great disaster.

Cooperation with the United States Geological Survey has continued, and reports were completed upon two forest reserves and the field work for two others was finished. In cooperation with the State geologist of Maryland an examination and report was completed for Allegany County. A short account of the Big Trees of California, with maps and illustrations, was prepared for the Senate Committee on Public Lands and afterwards reprinted as a bulletin, and an investigation was made of the forest on the watershed of Rock River in northern Illinois, where severe cutting, coupled with excessive artificial drainage, has very harmfully affected the regimen of the stream.

## THE EXHIBIT AT THE PARIS EXPOSITION.

An exhibit was prepared for the Paris Exposition, illustrating the relation of forests to agriculture in the United States. In addition to maps, a few remarkably fine specimens of trees, and a large number of photographs, the exhibit included colored transparencies of typical forest and agricultural lands, which are believed to be the largest ever made.

STUDY OF COMMERCIAL TREES AND OTHER INVESTIGATIVE WORK.

The studies of commercial trees, the object of which is to ascertain the rate of growth and production, and the other facts which are necessary for the best kind of practical forestry, were considerably extended during the year. Cooperation with the redwood lumbermen of California continued as before. The study of the Red Fir of the Pacific Coast was continued, and that of the Western Hemlock was begun. A study of the Longleaf Pine was begun and that of the Loblolly Pine was practically completed. The investigation of the Adirondack Fir, also begun, is particularly timely, because, with the decrease of the supply of Spruce, Fir is used more and more largely in the manufacture of paper. The data collected in the field for Adirondack hardwoods has been worked up into tables intended particularly to assist the private owner in managing his hardwood lands. Studies of numerous other trees have been continued or begun. The investigation of forest fires spread over twenty-six States and Territories, and many valuable results were reached. A history of forestry in New York and a summary of the forest laws now in operation in the various States are completed, and much material was gathered for other forest histories. An investigation upon the reliability of the widespread views regarding the effect of denudation upon the once forested lands bordering the Mediterranean Sea was begun; and in the series of studies of North American forests, reports on the Red Cedar, White Cedar, Cypress, and four commercial oaks were completed.

## OFFICE OF PUBLIC ROAD INQUIRIES.

EFFORTS TO SECURE AND DIFFUSE INFORMATION REGARDING ROAD MATERIALS.

There is much inquiry in all sections of the United States regarding better roads and better methods of building them. In order that the people might have accurate knowledge regarding road materials in our country, it has been deemed wise to divide the United States into four sections and appoint an expert agent in each of those subdivisions who has knowledge regarding geology and civil engineering. This has been done, and Mr. L. W. Page has been appointed in the Eastern States, Mr. J. A. Holmes in the Southern States, Mr. J. H. Stout in the prairie States, and Mr. James W. Abbott in the Rocky Mountain States. It is my intention that these experts, in connection with laying a scientific foundation for road building, shall also report regularly to this

Department for publication; that they shall on occasions lecture to students of educational institutions in their localities, and give them assistance where it may be required, furthering education along these lines.

It has been further arranged that these experts shall send samples of road material for analysis and testing along the several lines in which road material may be used. These tests will determine resistance to heat, moisture, and abrasion, and the cohesive qualities of the different materials.

It has been further arranged that a testing machine similar to that used at the Johns Hopkins University shall be constructed in the laboratory of the Division of Chemistry and the work put in charge of an expert. The putting of foundation work in charge of competent agents it is hoped will result in gaining scientific information upon which the people of all sections of the country may rely, and upon the establishment of a basis of this kind it is thought the people of the several States may proceed confidently to build roads most economically.

## INTEREST OF GOOD-ROADS PEOPLE IN SAMPLE-ROAD CONSTRUCTION.

The organized good-roads people, representing thirty-eight States, resolved at their late meeting at Chicago that $150,000 should be appropriated to enlarge the work of this Department, so that sample roads could be constructed in each State and Territory. This would require an addition of experts and machinery to the present force. Should Congress in its wisdom appropriate this or any other increased sum, every effort will be made to expend it to the best advantage. It was anticipated one year ago, when money was asked and granted to lay scientific foundations for road construction, that more money would be required every year. This action of the people, sympathized with by this Department, indicates full appreciation of expert work that should have been begun sooner.

## COOPERATIVE WORK.

The Office of Public Road Inquiries in this Department has been industrious in the last year in cooperating with people in the several States in the building of experimental roads, as well as with agricultural and other colleges and with volunteer associations that are interested in this line of work.

It has not been the intention of this Department to build roads for the people, but rather that our Office of Public Road Inquiries should cooperate with the people who undertake to build roads scientifically, and give them such help as is possible. We find a general spirit of cooperation; transportation companies throughout the country offer every encouragement to the work, carrying the Department's agents and road machinery free, and favoring us otherwise. More States and Territories were visited by representatives of the Office and more sample roads were built last year than in any previous year. The work of the Office has been more in States that have not carried this work on to any great extent within their borders. Congress has not been asked for large amounts of money up to the present time. It has been thought wise to lay foundations by scientific means wisely and well, and when the superstructure is being erected and when the interest in the several States and Territories becomes such as to require more expert help, Congress will be called upon for still more liberal appropriations. It is my opinion that the States and Territories should build their roads, but that the Federal Government should do scientific work for the whole country that all the States can not do quite so well for themselves. Excellent work is being done, however, in several of the States along this line, and one of the duties of this Office should be to ascertain what progress is made, along what lines it is being made, and according to what principles. Such information will then be given to the people of all the States for their instruction and guidance.

## OFFICE OF EXPERIMENT STATIONS.

### THE WORK AND SUCCESS OF THE STATIONS.

The work of the stations during the past year has for the most part been along the same lines as heretofore, and in the aggregate a large amount of useful work has been accomplished. By their own efforts and with the aid of the colleges of agriculture and the State boards or commissioners of agriculture the stations are bringing their work home more closely to the farmers through publications, farmers' institutes, agricultural associations, home-reading courses, and the press. It is becoming evident that farm practice in this country is being materially affected by the work of the stations, and they are more and more relied upon by our progressive farmers for advice and assistance.

It is now twenty-five years since agricultural experiment stations were first established in this country, beginning their work under the auspices of the States and the agricultural colleges. For half this period their operations were very limited in extent and scope. When the Hatch Act was passed, in 1887, stations had been established in only fourteen States. The sudden expansion of this enterprise to cover the entire country, and the great increase in the scope and variety of the work, as well as lack of available funds, made the task of the development of these institutions very great and arduous. The successful establishment of the stations on a permanent basis in all the States and Territories, and the great success which on the whole has attended their work, is very remarkable. It is now generally recognized that we have in this country the most complete and efficient system of agricultural experiment stations which exists anywhere in the world. They have secured the confidence and esteem of our farmers to a most gratifying extent, and will enter upon the new century with a most promising outlook for continued and extended success.

A quite comprehensive survey of the history and present status of the stations has been made by the Office of Experiment Stations during the past year in connection with the exhibit of the stations at the Paris Exposition. This is comprised in a volume of over 600 pages, with some 300 illustrations. Under the law only 1,000 copies of this publication could be issued, and a large share of these were distributed to the representatives of foreign nations at the exposition. It would be well, however, if our own people could be made more thoroughly acquainted with the extent and success of this great enterprise on behalf of the vast agricultural interests of the United States, and I hope that Congress will make provision for another edition of this volume for distribution in this country.

A considerable number of the States have continued to supplement the funds given to the stations by the National Government. The total revenues of the stations during the past year amounted to about $1,200,000, of which $720,000 was received from the National Government and about $440,000 from State governments and other local sources. The stations now employ nearly 700 persons in the work of administration and investigation, and during 1899 published 445 annual reports and bulletins which were distributed to more than half a million addresses.

As the work of both college and station grows in extent and complexity, it becomes more apparent that in order to perform the most efficient service the station should be organized strictly as a separate department of the institution with which it is connected, and that it should have an organization so compact that its work may proceed in accordance with a schedule carefully planned and energetically administered. To secure this end, experience shows that it is quite desirable that the station should have a competent executive officer who can devote his time to planning and directing its operations, managing its general business, and representing its interests before the public. It is encouraging to observe that in several States during the past year these considerations have led to the more complete separation of the business of the station from the general business of the college and to the appointment of a director of the station as a separate officer.

### THE INSPECTION SERVICE OF THE STATIONS.

The amount and variety of inspection service required of our experiment stations continue to grow from year to year. Beginning with the inspection of commercial fertilizers when the stations in the East were first established, it now includes feeding stuffs, dairy products, and other foods for man, creamery glassware, insecticides, nursery stock, and plant and animal diseases. The problems relating to this service now affect the stations in all sections of the country, since there is no region which does not have some evil against which the agricultural public is demanding protection by inspection under State or national auspices. It becomes therefore of considerable importance to have a careful consideration of the policy of our stations regarding this matter.

Soon after the establishment of the stations under the Hatch Act this Department ruled that the funds appropriated under this act could not be legitimately applied to pay the expenses of the inspection and control of fertilizers. The same principle holds good with reference to other forms of inspection service demanded of the stations. While the methods and usefulness of inspection in any particular line are still problematical, it may be justifiable for a station to undertake this work to a limited extent, but as soon as it becomes a matter of routine business the State should provide funds for its maintenance. If it seems expedient that any part of the inspection service should be performed by the station under State laws and at State expense, the matter should be so arranged as not in any way to interfere with the investigations of the station. It is a great mistake to divert the time and energy of competent investigators to the toilsome routine work of inspection service. It is often supposed that because this Department performs such service at the same time it is carrying on a large amount of original investigation, that the stations should necessarily pursue the same course. This is by no means a correct view of the matter. This Department is by law organized as an administrative agency as well as a great scientific institution. The stations, on the other hand, as far as the Hatch Act is concerned, are departments of educational institutions, and by the terms of that act are organized solely to carry on investigations for the benefit of agriculture. It is only as they have been given other duties by State laws that they have properly extended their operations in other directions.

### COOPERATION OF THE STATIONS WITH THE DEPARTMENT.

During the past year the Department, through its different Divisions, has inaugurated or continued cooperative enterprises with the experiment stations in nearly all the States and Territories. Among the subjects on which cooperative investigations are being conducted are the following: Tests of varieties of grasses and forage plants in many localities; special experiments with grasses and forage plants for the arid region, and the improvement of range lands; breeding experiments with plants; experiments with hybrid orange trees; the culture of dates, tea, and tobacco; planting of forest trees; investigations on the nutrition of farm animals and of man; investigations with reference to the effect of feeding stuffs on the chemical composition and physical character of butter; studies of diseases of plants and animals; studies of alkali soils and seepage; the survey and mapping of soils; and irrigation investigations.

The cooperative enterprises in which the Department and stations are engaged have not only increased in number but also in scope and variety. Besides the more formal enterprises which involve the expenditure of more or less money on both sides, there are many minor ways in which the officers of the Department and the stations are helping each other. The Department has thus been brought into much closer relations with the stations.

The stations are becoming more alive to the advantages of such cooperation, and are therefore more willing to engage in it under proper conditions. They see in this a way to extend and make more efficient the investigations in which they are themselves already engaged, and also to undertake certain lines of work much needed in their respective regions, from which they have hitherto been debarred from lack of funds. By a more intimate association with the Department on terms which recognize their autonomy and local authority, they generally believe that greater stability may be secured for their operations and an increased measure of influence may be obtained with their own constituencies.

Questions relating to the more efficient organization of these cooperative enterprises have engaged the attention of the officers of both the Department and the stations during the past year, and with the establishment of a fixed policy regarding this work and its more thorough organization, it is believed that it may be greatly extended, and thereby the efficiency of both the Department and the stations, as organizations for the improvement of our agriculture, may be greatly increased.

The policy pursued by Congress in recent years of giving this Department funds for special investigations to be carried on in cooperation with the stations has proved an economical means of conducting such investigations as are of general rather than local usefulness, and has already secured results of great practical value.

### EXPERIMENTS IN COOPERATION WITH FARMERS.

The number and importance of the experiments which the stations are conducting in cooperation with practical farmers and horticulturists have greatly increased of late. Thousands of such experiments are now annually conducted in the United States. These range all the way from simple tests of varieties of plants to special experiments in the management of farm or horticultural crops, live stock, or particular operations, such as tobacco curing. It is coming to be more clearly recognized that the field operations in agriculture or horticulture, conducted on the station farm, need to be supplemented by similar work in a considerable number of localities in order to be of general usefulness to the State. In experiments with orchard fruits it is often better for the station to make arrangements to work orchards already established. Special investigations of different kinds must be carried on away from the station in order to be of any use. By going into different localities, as the needs of its work demand, the station can make itself more useful to the State as a whole. Without doubt cooperative experiments need to be very carefully planned and thoroughly supervised to be successfully conducted, and their success depends on their quality rather than on their number. It is encouraging to observe that more careful attention is being given to this important matter by station officers, and it is believed that this work may be made much more economical and useful than the permanent substations as ordinarily managed.

### AGRICULTURAL EXPERIMENT STATIONS IN ALASKA.

Having received authority from Congress to establish and maintain agricultural experiment stations in Alaska, as well as to investigate the agricultural resources and capabilities of that Territory, I have endeavored to put this enterprise on a more permanent basis. Headquarters having been established at Sitka, as the capital of the Territory, the construction of a building for office and laboratory purposes has been undertaken. The lower story of this building has been so far completed that it is now in use. A few acres of land have also been cleared at Sitka on the station reservation. A station has been established at Kenai, Cook Inlet, and during the past summer reservations of land for station purposes have been made at several points in the valley of the Yukon River. The experiments thus far made have consisted largely in growing different varieties of cereals, forage plants, flax, and vegetables. Experiments in making and storing silage and in making hay from native grasses have been tried to a limited extent. The correction of the acidity of new land with lime has been successfully tried. Much information regarding agricultural conditions in different parts of Alaska has been obtained through circulars of inquiry and the visits of our agents to different localities. Seeds have been distributed in a number of different regions and reports have in many instances been received of the first trials with these seeds. Sufficient evidence has been obtained to show definitely that a considerable variety of vegetables can be successfully grown in different parts of Alaska. It has also been shown that in southeastern Alaska and in Cook Inlet oats, barley, buckwheat, and spring wheat will mature with careful culture and that the failure of many attempts to grow crops in Alaska has been due to the natural acidity of the soil and the lack of drainage. When these difficulties are removed by proper treatment the land is fertile and productive.

During the past summer Professor Georgeson, the agent in charge of the Alaska experiment stations, and one assistant made a journey in the interior and examined especially the agricultural capabilities of the Yukon Valley, going as far as Dawson. Under date of July 4 Professor Georgeson wrote as follows:

I am very favorably impressed with the agricultural possibilities of the country as far as I have seen them. While the banks of the river are generally hilly and in places mountainous, there are also large areas of excellent agricultural land; and best proof of all, they have here in the rooms of the chamber of commerce very fine samples of wheat, barley, and oats which were raised here at Dawson last year. The grain is plump and fully matured. As soon as we pass the coast range the glaciers and snow entirely disappear. I have not discovered a speck of snow even on the highest mountains in sight. Along the river the native vegetation seems vigorous, and in many places the slopes are covered with a profusion of flowers. Here at Dawson are three successful market gardens, and the town is well supplied with early vegetables, especially lettuce and radishes. It gets occasionally uncomfortably hot here. They tell me that the mercury has been up to 96° F. twice already this summer.

There is evidently much misconception regarding the work which the Department is attempting to do in Alaska. Persons who are unfamiliar with the work of experiment stations have criticised our operations at Sitka and elsewhere because they are conducted on so small a scale. In this respect, however, they do not differ materially from similar experiments at the experiment stations generally, where it is the usual practice to test different varieties of plants first on small plats. In this way it is entirely feasible to determine in a general way the adaptability of a region to the growing of different kinds of plants, and what varieties of these plants are likely to be most successfully grown. The plat tests should be supplemented by field and garden trials on a larger scale, and this we shall do in Alaska as soon as it is practicable.

It has been said over and over again that Alaska can never become an agricultural country, and this is undoubtedly true in the sense in which the criticism is made—that is, Alaska will never become a region in which the soil will be generally cultivated as it is in most other parts of the United States, and especially in the Mississippi Valley. There is at present no agriculture in Alaska. Successful attempts have, however, been made in growing vegetables in a considerable number of places in different parts of the Territory, and here and there fields of potatoes and oats have been grown and a few head of live stock have been maintained. Native grasses grow abundantly over large areas, and here and there have been successfully utilized for hay and silage.

The problem which the Department has undertaken to work out is to determine whether a sufficient agriculture and horticulture can be developed in Alaska to form an important subsidiary industry to aid in the permanent development of mining, fisheries, and lumbering, which will undoubtedly be the leading industries of this region. If all the food supplies of the population engaged in these industries must be transported from the United States and Canada, it is evident that the development of Alaska will be much slower and more uncertain than if a considerable portion of these supplies can be produced in the Territory. It has already been shown that the green vegetables raised in Alaska have been an important factor in maintaining the health of the mining communities. If our investigations should do nothing more than establish on a sound basis the growing of vegetables in little gardens about the cottages of miners and fishermen in Alaska, they will make an adequate return for the funds expended on them. But there is a fair prospect that they will do much more than this. There are large areas on the western peninsula, in Cook Inlet, and on the islands which are naturally adapted to the growing of live stock. The fact that a considerable number of domestic animals have already been maintained in this region would seem to show that an animal industry might be developed there. The Department will attempt to find out under what conditions this can best be done.

The growing of grain and other forage crops on a large scale in this region and in the interior is still problematical. The experiments which the Department has thus far conducted have been very largely made with reference to the determination of general agricultural possibilities of the Territory. The growing to maturity of such plants as wheat and oats in any region, even in small quantities, furnishes an excellent indication of the climatic and soil conditions of that region with reference to its agricultural possibilities, for we know quite definitely what is required for the maturing of such plants.

In southern Alaska, which is the only part of Alaska seen by most tourists, the forests cover most of the land. The natural meadows, which occur in considerable numbers, are usually of quite limited extent, and for the most part escape the notice of visitors pursuing the ordinary lines of travel. The clearing of land for agricultural purposes in this region will necessarily be expensive, and will only be done as lumbering takes away the trees and increase of population makes a demand for agricultural products. In most respects this region does not differ materially from that of Puget Sound. It is probable that ultimately it will become the home of a considerable population, part of whom will engage in agriculture; the growing of such crops as oats, barley, potatoes, buckwheat, turnips, and other vegetables, together with dairying, will become important industries, and it is probable that flax will be largely grown for its fiber here, as it will be in western Washington and Oregon.

For a considerable period our operations will largely partake of the nature of an agricultural survey, to determine where agricultural operations may best be carried on by incoming settlers. By active work along the lines already marked out, it is believed that the experiment station in Alaska will prove an efficient aid in the development of the Territory, and will thus justify the expenditures for their maintenance. Considering the fact that the mining and other industries of Alaska are already producing millions of dollars annually, it seems as if the National Government might very properly expend a reasonable sum in aiding the establishment of agriculture, for the sake of the greater permanence and more satisfactory development of these largely productive industries.

That Alaska will ultimately have a considerable permanent population there can be but little doubt. As we have shown in previous reports, Finland is the country which, on the whole, furnishes the best basis of comparison with Alaska as regards natural conditions. Finland supports a population of two and one-half million, and its agriculture has reached a high state of development. In 1895 there were produced in Finland 38,174,083 bushels of barley, oats, and rye, of which 1,396,200 bushels of oats were exported. At the same time there were 300,650 horses, 2,398,183 cattle, 1,067,384 sheep, and 197,356 hogs. During the period from 1891 to 1895 there were annual exportations of about 22,750,000 pounds of butter, 400,000 pounds of cheese, and 400,000 gallons of milk, or a value of $6,750,000 from dairy products alone. Very conservative estimates of the agricultural possibilities of Alaska indicate that agriculture may be regularly and successfully carried on over an area fully as large as that of Finland.

In the development of the experiment stations in Alaska, account must always be taken of the vast area of the Territory, and the difficulties and expense of transportation under present conditions. These stations do not have the backing of educational institutions, or a large population interested in agriculture, as is the case elsewhere in the United States. All their expenses for building, equipment, and services must be paid from the national appropriation. For the ensuing fiscal year the appropriation should be at least $15,000. Heretofore a portion of the appropriation has been made immediately available, but this has proved to be an unfortunate arrangement, especially in the year in which the long session of Congress occurs, when the appropriation act for this Department may not pass until near the end of the fiscal year. I would suggest, therefore, that an appropriation of $3,000 be made to cover the expenses from April to June, 1901, in lieu of the immediately available appropriation hitherto made and in addition to an appropriation of $15,000 to cover the operations of the entire fiscal year of 1902.

AGRICULTURAL EXPERIMENT STATIONS IN HAWAII AND PORTO RICO.

In accordance with the recommendation in my Report of 1899, Congress made an appropriation of $10,000 for the establishment and maintenance of an agricultural experiment station in Hawaii. In order to ascertain definitely the condition of the agriculture of that Territory, Dr. W. C. Stubbs, who for many years has been the successful director of the three experiment stations in the State of Louisiana, was sent to the Hawaiian Islands, where he made a careful investigation with special reference to the organization and work of an experiment station. In his report he recommends that a station be established under the direct control of this Department and independent of existing local institutions. As the station already maintained by the Hawaiian Sugar Planters' Association will continue its work on problems relating to the sugar industry, he recommends that the station to be established by this Department give its attention to other agricultural interests. Among the subjects which require special attention are the culture of fruits and vegetables, coffee growing, stock raising, dairying, irrigation, forestry, and diseases of plants.

For Porto Rico an appropriation of $5,000 was made to determine the agricultural conditions existing in that island, with special reference to the more desirable localities for agricultural experiment stations, as well as the subjects on which the agricultural people of the island are in most immediate need of practical information, and how this need can be most economically and effectively supplied. With a view to determining these questions, Prof. S. A. Knapp, formerly of the Iowa Agricultural College, and more recently engaged in agricultural enterprises in southern Louisiana, was sent to the island. He found that there was urgent need of agricultural education and investigation to promote the interests of agriculture there, and recommends the establishment of an experiment station in the vicinity of San Juan. He also urges that this station be established on a broad basis, special attention being given at the outset to demonstration experiments and the dissemination of information regarding improved methods of agriculture. Among the subjects to which the station should direct its attention are the improvement of the culture of coffee, sugar, and tobacco; the encouragement of the production of food supplies for home consumption; the improvement of live stock; the making of cheese and butter; and forestry.

As a result of these investigations, I am convinced that experiment stations should be established in Hawaii and Porto Rico, as in other parts of the United States, and that these island Territories should receive an annual appropriation for experiment stations equal to that which is given to the other Territories. This Department is prepared to take active measures for the establishment of these stations as soon as Congress has declared its policy in this matter.

### AGRICULTURAL EXPERIMENT STATIONS IN THE PHILIPPINES.

Owing to the disturbed political conditions existing in the Philippines, we have not deemed it wise to make any specific recommendation this year for an appropriation for experiment stations in those islands. There is, however, no doubt that such stations will be needed there and should be organized just as soon as there is a reasonable prospect that their operations can be regularly and efficiently conducted. In considering the measures necessary for the establishment of a permanent government in the Philippines the need of agencies for the education of the people in agricultural lines and for the investigation of agricultural problems should receive careful consideration.

### INVESTIGATIONS ON THE NUTRITION OF MAN.

The investigations on the food and nutrition of man have been continued the past year on the same lines as heretofore, including studies on the nutritive value and cost of different food materials in various parts of the United States, special investigations on the relative digestibility of different foods, and the transformation of the energy of food materials in the body and the use which the body makes of the energy so transformed. These investigations have been largely carried on as hitherto in cooperation with agricultural experiment stations and agricultural colleges and other educational institutions in different parts of the country.

Six bulletins on these investigations have been published during the past year. The subject of these investigations is one that touches every household, as well as numerous public institutions and the Army and Navy, and the results obtained in them may be made of direct practical value.

A demand for the extension of these investigations has arisen from several sources. The results of this work affect both the producers and the consumers of our agricultural products. There is a wide demand on the part of the producers for accurate information which will enable them to improve their products in accordance with the real needs of the users. Consumers, on the other hand, are seeking information which will enable them to secure such products as will give them best nourishment at a reasonable cost. The movement for the application of scientific knowledge to the conduct of public institutions and homes is gathering strength each year. Household economics is rapidly taking its place among the required studies of our institutions of learning, and the demand for reliable information and for popular and technical literature on such topics is rapidly increasing.

The investigations of this Department having now become well established and having proved highly successful, should be developed as the demand for them increases, and I therefore recommend that the appropriation for this work for the coming fiscal year be increased to $20,000.

### IRRIGATION INVESTIGATIONS.

Much progress has been made during the past year in the organization and development of the irrigation investigations conducted through the Office of Experiment Stations.

In accordance with the terms of the appropriation act, two general lines of investigation have been pursued: (1) The study of the laws and institutions relating to irrigation in different regions and (2) the determination of the actual use made of irrigation waters.

The largest single enterprise connected with these investigations has been in the State of California. The growing value and increasing scarcity of water in that State are creating imperative need of better laws to control the distribution of streams, and there is much public interest in this subject. This local interest has been shown in a most substantial and gratifying form by the cooperation of the California Water and Forest Association in our work and the contribution of several thousand dollars to be expended under the direction of the agents of the Department. The University of California and Leland Stanford University have also given efficient aid to this enterprise, and have been represented on the staff of agents employed in the prosecution of the work.

Eight typical streams in different parts of the State have been thoroughly studied with reference to the conditions under which the water for irrigation is owned, distributed, and used. A comprehensive report on these investigations is now in course of preparation. It is believed that this is the largest and most comprehensive inquiry regarding irrigation laws, customs, and conditions which has been undertaken in this country. Similar investigations, though on a smaller scale, have been made in Utah, Colorado, and other States.

The measurements of the duty of water undertaken last year have been extended this season, regular stations for this purpose having been maintained in eleven States and Territories in the irrigated region. A detailed report on the observations of the previous season is now in press, which includes a larger amount of data on this subject than has ever been brought together before. Studies of the losses from evaporation and seepage and of the amount and character of sediment contained in irrigation waters have also been carried on in a number of localities.

Interest in the use of irrigation to supplement rainfall in the humid regions of the United States is constantly growing. In a number of sections this has been greatly stimulated during the past season by long-continued drought. Interesting and valuable investigations regarding the use of water for irrigation in New Jersey have been made by Professor Voorhees, director of the New Jersey agricultural experiment stations. The results of these investigations have recently been published, and they indicate that the practice of irrigation has been quite profitable in that State as far as it has been tried.

Similar investigations are being undertaken in Missouri and Wisconsin in cooperation with the experiment stations in those States. A preliminary survey was also made of the conditions of irrigation practice in the rice fields and sugar plantations of the Southern States. This indicated that there is great opportunity for improvement in the methods and use of water in that region, and it is hoped that it may be possible to undertake a study of some of these problems in the near future.

A report on the irrigation system of Hawaii is now in press. A popular bulletin on the practice of irrigation in connection with horticulture has been issued and widely distributed.

Although the irrigation investigations now in charge of this Department have been in progress too short a time to permit the publication of extended reports, it is believed that they have already had important results. As the basis for these investigations, an effort has been made to ascertain the actual needs of the people of the irrigated region as regards the investigation of irrigation problems. This has led to widespread discussion of this subject in agricultural and other associations, as well as in the public press. Through the publications of this Department already issued and the addresses of our agents in public meetings in different parts of the irrigated region, the existing conditions have been described as accurately as a preliminary survey would permit. The lines along which investigations must proceed have also been definitely pointed out. In this way the experience already obtained by the experiment stations, State engineers, and officers and experts in irrigation matters has been brought to bear on the public mind more effectively than heretofore. The result has been a great quickening of interest in this matter throughout the West, together with a larger and more definite realization of the importance of the development of our irrigation system and the intricate nature of the problems involved. A great desire has been awakened to have an accurate and complete showing of facts, on which permanent improvement alone can be based. This has led to hearty cooperation of the people and local authorities in our investigations wherever they have been undertaken and demands for our work far beyond our ability to meet.

While the earnestness with which these demands are pressed is very largely due to the urgent needs of localities and individual farmers and ditch owners for the remedying of evils affecting their immediate interests, it is also beginning to be seen quite clearly that the questions involved in this and kindred investigations have a direct bearing on the problems which are of national and even international importance. On the supply of water for irrigation and its equitable distribution, depends the permanent existence of civilized life in one-third the area covered by the forty-eight States and Territories of the Union. Questions relating to irrigation are vital not only to agricultural, but also to all other interests of this vast region, and the ultimate solution of the problems relating to irrigation will be found not only in State legislation and administration, but also in the action of the National Government. Most of the streams used for irrigation cross State lines, and some of them run partly in foreign countries.

The nation still owns large areas, the development of which will necessarily depend on national land laws recognizing the importance of extending the irrigated region as far as possible. Sooner or later these questions must be taken up by the United States as well as by the individual States and settled on a just basis and in accordance with actual conditions. What is needed in this matter at the present time above everything else is the impartial ascertaining and recording of the facts relating to irrigation in this country. It is this task which this Department has set for itself. It is believed that an efficient organization for the prosecution of this work has been established and that in this way a basis has been laid for the prosecution and extension of the work as rapidly as the necessary conditions of the investigations and the available funds will permit.

In view of the urgent need for the extension of these investigations, I recommend that the appropriation for the ensuing fiscal year be increased from $50,000 to $75,000.

## SECTION OF FOREIGN MARKETS.

### THE PURPOSE OF THE SECTION.

The work of this Section is directed especially to carrying out the provision in the appropriation act which enjoins on the Secretary of Agriculture to study "the feasibility of extending the demands of foreign markets for the agricultural products of the United States." In the fulfillment of this purpose every effort is made to keep the Section adequately equipped and to maintain its work at the highest standard of efficiency. The question of supply and demand in foreign markets particularly is earnestly studied, and the publications of the Section are directed especially to affording information on this important subject. The records of this Section show an extraordinary development of the foreign demand for our agricultural products, which, in view of its important effect upon prices at home, is most gratifying.

## AGRICULTURAL EXPORTS.

While the wonderful growth attending the exportation of domestic manufactures has, it is true, somewhat reduced the relative proportion of farm products comprised in our total exports, the increase in our agricultural exports during the period covered by the present Administration has nevertheless been most remarkable.

Our total sales of domestic farm products to foreign countries during the four fiscal years 1897–1900 aggregated the enormous sum of $3,186,000,000, or close to $800,000,000 in excess of the export value for the preceding four-year period. In other words, we received on an average during 1897–1900 for products of domestic agriculture marketed abroad nearly $200,000,000 a year above the annual amount paid us for such products during 1893–1896.

The agricultural exports of the United States for the fiscal year ended June 30, 1900, amounted in value to $844,000,000, exceeding all other records except the phenomenal one of 1898, when a valuation of $859,000,000 was attained. During the past four years, 1897–1900, the farm produce exported had an average annual value of $797,000,000, as compared with only $598,000,000 for the prior four-year period.

## EXPORTS TO THE ORIENT.

One of the most striking features of our foreign trade during the last few years has been the rapid growth of exports to the Orient. In 1896, five years ago, our total shipments of domestic merchandise to Asia and Oceania were valued at $43,000,000, and these exports included agricultural products to the value of $9,700,000. During the following year, 1897, the total export value rose to $62,000,000, while the amount received for products of the farm increased to $15,000,000. Each succeeding year, in like manner, has witnessed further striking gains, until in 1900 our export trade with the Orient exhibited an annual value of $107,000,000, including shipments of farm produce worth $30,000,000. The growth of our agricultural exports to that quarter of the globe—from $9,700,000 in 1896 to $30,000,000 in 1900—was especially marked, showing a gain that amounted in the brief space of four years to over 200 per cent.

One of the most striking examples of increase among our agricultural exports to the Orient is afforded by the great Southern staple, cotton. Of this product, we shipped across the Pacific in 1896 only 38,000 bales, valued at $1,500,000, whereas our exports to the same destination in 1900 were nearly ten times as large, amounting to 325,000 bales, valued at over $13,000,000.

It is interesting to note that, with the increased shipments of the raw fiber, there was also a marked growth in the exports of cotton manufactures. During 1900 our cotton manufacturers shipped over

$12,000,000 worth of goods to the Orient, as against only $5,500,000 worth during 1896, five years ago. The cotton fabrics we marketed in the Orient during the past fiscal year formed in value more than 50 per cent of our total exports of these goods to all destinations.

After cotton, the principal article among our agricultural exports to the Orient is wheat flour. The trade in this product has been nearly doubled since 1896. In that year the shipments amounted to 1,211,000 barrels, worth $3,600,000, whereas in 1900 they reached as high as 2,378,000 barrels, worth over $7,000,000,

### MARKETS IN THE NEW DEPENDENCIES.

During the past fiscal year the new island dependencies of the United States—Cuba, Porto Rico, the Hawaiian Islands, and the Philippines—furnished a market for more than $45,000,000 worth of our domestic products, manufactured and agricultural. Five years ago these same islands purchased from us only $13,000,000 worth of goods. In the four years subsequent to 1896 our export trade with the islands mentioned has been more than trebled in value.

A comparison of our total domestic exports for the years 1896 and 1900 shows that the value increased in the case of Cuba from $7,300,000 to $25,000,000, Porto Rico from $2,100,000 to $4,300,000, the Hawaiian Islands from $3,900,000 to $13,000,000, and the Philippines from less than $200,000 to over $2,600,000.

The growth of our agricultural exports to the new dependencies during these years was proportionately as great as that recorded for our total exports of domestic merchandise. During the fiscal year 1900 we sold to the various islands over $20,000,000 worth of farm produce, as compared with only $6,300,000 worth during 1896.

With Cuba our agricultural export trade in the period under consideration increased from $4,000,000 to $14,000,000, with Porto Rico from $1,200,000 to $2,300,000, with the Hawaiian Islands from $1,100,000 to $2,800,000, and with the Philippines from less than $23,000 to $1,700,000.

## DIVISION OF PUBLICATIONS.

### GROWTH OF THE PUBLICATION WORK.

The publication work of the Department necessarily grows step by step with the growth of the Department at large. The diffusion of useful information is obviously as important a part of the duty imposed upon the Department as its acquisition. Every effort has been made to discriminate in the distribution of our publications so as to minimize the waste which is inseparable to greater or less extent from a system of free distribution. It is, however, a flattering tribute to the work of this Department, that in spite of the very considerable increase in the number of publications issued, the demand for them has increased in a far greater degree, so that last year, with the largest number of copies of all publications ever attained, aggregating considerably over 7,000,000, the refusals to applicants were at least ten times more numerous than six years ago, when the total number of copies of the Department publications aggregated barely more than half that number.

It is obviously impossible to reduce the number of publications. These must always depend upon the work accomplished in the several Bureaus, Divisions, and Offices. At the same time, to reduce to any important extent the number of copies issued, in the face of the rapidly increasing demand, would sadly restrict the scope of our service to the farmers.

The above facts show that one of the problems urgently calling for solution is that of supplying facilities for prompt diffusion of the information acquired as the result of the work and investigations of the several Bureaus, Divisions, and Offices of the Department. The general printing fund made available for our use was exhausted long before the close of the fiscal year, and many valuable publications were unfortunately delayed thereby. I have been forced to ask for an increase in this fund for the ensuing year. It is a question, however, whether, without some change in the present system of distribution, it will be possible to maintain a supply equal to the demand in the matter of Department publications.

The report of the Department Editor shows that for the fiscal year 1900 the number of new publications issued from the Department was 320, against 297 for 1899. Of reprints, however, there were only 148 in 1900, as against 306 in 1899. The total number of copies of all publications in 1900 was 7,152,478.

Since the writer assumed control of the Department and up to the close of the fiscal year 1900, there have been issued over 1,600 different publications, aggregating over 21,000,000 copies.

### FARMERS' BULLETINS.

The Farmers' Bulletins continue to fill a most useful purpose. Indeed, it would be difficult to achieve a wider diffusion of practical information in proportion to cost than is accomplished by these publications. The total number of Farmers' Bulletins issued during the year, including reprints, was 108, aggregating 2,360,000 copies. The total number of copies of these bulletins issued from the beginning aggregate 13,630,500. Of this enormous number, over 7,000,000 copies have been issued during the present Administration, and the total number of copies distributed since the beginning through the Senators, Representatives, and Delegates in Congress exceeds eight and a half millions. At its last session, Congress showed its appreciation of this form of publication by a large increase in the appropriation devoted to the preparation and printing of these bulletins, and providing for a distribution through Senators, Representatives, and Delegates of four-fifths of the number of copies printed in lieu of two-thirds, as heretofore.

### THE YEARBOOK.

The Yearbook for 1899 was prepared with the express purpose of making a book especially adapted to circulation in the last year of the century, and contains a review, by each officer of the Department having charge of a special line of work, of the development of and practical results obtained in the line of scientific investigation with which he is connected. Like its predecessors, this book has, I am glad to say, been received with marked favor.

The coincidence of the Paris Exposition with the year of issue of a Yearbook specially devoted to reviewing the progress of agricultural science and enterprise during the past century was sufficiently interesting to induce Congress to authorize the issue of a special edition of the work, mainly for distribution abroad, to be known as the Paris Exposition edition, and to be printed on extra paper, with special binding. This part of the work was admirably carried out by the Public Printer, and the result is a souvenir volume of a most appropriate and attractive character, very highly appreciated by the distinguished persons by whom it is received, and conveying at the same time a worthy tribute to the great industrial exposition held in the last year of the century in the French capital.

### WORK INVOLVED IN DISTRIBUTION OF PUBLICATIONS.

The report of the Department Editor lays special stress upon the very large amount of work devolving upon himself and his assistants and the clerks and laborers employed in the distribution of publications. It appears that the total number of replies to communications received in the Division of Publications exceeded 290,000 during the year. Nine thousand of these replies were in the form of written letters, the others consisting of partially printed blanks, postal cards, and circulars. In addition to these, some 9,000 letters were written in the main office of the Division, making a total of 300,000 separate communications prepared, addressed, and mailed in that Division during the year. In the same period there were, moreover, 3,340,349 names and addresses written, covering the folding and dispatch of more than 6,300,000 separate documents. The keeping of registers of all publications, save circulars, and 391 separate ledger accounts for Farmers' Bulletins with Senators, Representatives, and Delegates adds very much to the clerical and bookkeeping work of the Division, which involves also the keeping of accounts covering three several funds, aggregating over $180,000, besides separate accounts of publication and illustration expenditures with each Bureau, Division, and Office of the Department.

### NEED OF MORE SUITABLE ACCOMMODATIONS.

Much stress is also, and very justly, laid in the report under consideration upon the sadly inadequate and unsuitable accommodations provided for the work of this Division, a condition which it is, I regret to say, under existing circumstances entirely out of my power to remedy. The condition of affairs in the Division of Publications simply affords one additional argument as to the urgent necessity of new and enlarged accommodations for the Department of Agriculture.

## THE LIBRARY.

### GROWTH OF THE LIBRARY.

Additions to the Library during the past year have numbered about 5,000 volumes. A larger proportion of the additions has come by way of exchange than ever before, owing to arrangements for exchange made by the Librarian as a result of a personal visit to various points in Europe. These arrangements have a salutary effect in bringing to the attention of scientific bodies in other countries the numerous valuable scientific publications of the Department, adding prestige to the Department as a whole and to its scientific workers in particular.

### CARD INDEX.

Cards have been issued containing entries of all articles in the Yearbooks and Farmers' Bulletins issued by the Department; these have been printed and distributed to nearly 4,000 libraries, thus assisting in the efforts to make these publications more available to readers.

### CARD CATALOGUE.

The additions to the card catalogue have been so great that it is probable that it will be in shape to be printed within a year or two. Such a catalogue, if printed, would be of the greatest use to workers in agricultural experimentation wherever located.

## DIVISION OF STATISTICS.

In view of the near approach of the time when the reports of the census will render possible that broadening of the scope of the statistical work of this Department, which is so much to be desired but which could not be undertaken with advantage during the closing years of an intercensal period, the efforts of the Statistician have been mainly directed to strengthening and otherwise improving the Department's several crop-reporting agencies. The most important step that has been taken to this end has been the appointment of two statistical field agents, who are devoting their entire time to a progressive and systematic visitation of the principal centers of the agricultural industry.

While the Statistician makes the gratifying statement that the reports received from the Department's regular correspondents were never before so numerous, so complete, so regular, or so prompt, he attributes that greater accuracy of his reports, which has been so ungrudgingly acknowledged by the commercial press of the country, largely to the work of these traveling agents, who have not only made personal investigations from time to time, but have brought the Statistician into closer touch with the State statistical agents and other principal correspondents.

That broadening of the scope of the statistical work of the Department which will immediately follow the publication of the census reports will involve an increased expenditure, either in the payment of some small sum to correspondents, who can not reasonably be called upon to do more than they are now doing without compensation, or in an increase to the clerical force of the Division, rendered necessary by an increase in the number of correspondents and a redistribution among them of the different classes of products reported upon.

Great efforts have also been made to add to the completeness and reliability of the statistics of foreign crops. Arrangements have been made with the Hungarian Minister of Agriculture for an exchange of summarized crop reports by cable; a similar arrangement is in course of negotiation with the Government of Germany, and it is expected that all the principal grain-producing countries of the world will become parties to like arrangements before the crop season of 1901 is far advanced.

The Statistician urges that advantage should be taken of the recent farm-to-farm visitation in Hawaii and Porto Rico, and the collection of certain agricultural statistics, to extend to those islands the regular statistical work of this Department, such a statistical basis as is furnished by the census being indispensable to any proper system of crop reporting.

### SEED DIVISION.

It appears from the report of the Assistant Secretary on the purchase and distribution of seeds, that of the total appropriation for this purpose of $130,000 there has been expended during the fiscal year $127,654, of which $24,293.73 was for salaries of employees engaged in seed distribution and $20,000 was devoted as provided by Congress for the purchase of rare and valuable foreign seeds and plants distributed through the agency of the Section of Seed and Plant Introduction, and which have already been covered in the present Report.

The records of the Seed Division show that apart from $2,120.91 expended for miscellaneous seeds and $1,663 for vegetable and field seeds distributed to sufferers by flood in Texas, there were purchased 14,738,968 packets of seeds of all sorts, of which 13,531,469 were distributed to Senators, Representatives, and Delegates in Congress, an excess over the two-thirds reserved by law for Members of Congress of 3,705,490 packets.

## DIVISION OF ACCOUNTS AND DISBURSEMENTS.

The appropriation made by Congress for the United States Department of Agriculture for the fiscal year ended June 30, 1900, was $3,006,022. This appropriation exceeded the amount appropriated for 1899 by $176,320. The usual sum of $720,000 was also appropriated for equal division among the forty-eight agricultural experiment stations of the country.

The expenditures and liabilities incurred during the year in connection with the first-named amount were about $2,975,000.

The unexpended balances of the appropriations for the fiscal year 1898, amounting to $42,391.42, were covered into the Treasury June 30, 1900. During the year $4,440 was paid for rental for leased buildings in Washington, D. C.

## THE PARIS EXPOSITION AWARDS.

The final official list of the American awards at the Paris Exposition has not yet reached me; but the preliminary reports forwarded by the Department's representatives at the exposition show that in the department of agriculture, horticulture, and food products the awards to United States exhibitors numbered 490. In group 7, agriculture, the awards were 28 grand prizes, 93 gold medals, 100 silver medals, 49 bronze medals, and 4 honorable mentions. In group 8, horticulture, awards on permanent exhibits were 1 grand prize, 4 gold medals, 18 silver medals, 7 bronze medals, and 6 honorable mentions. Exhibitors of perishable horticultural products from the United States, in the several temporary competitions in horticulture, were awarded 5 grand prizes, 80 gold medals, 63 silver medals, 17 bronze medals, and 10 honorable mentions. These temporary competitions were held at intervals of two or three weeks throughout the season. The United States was the only country which maintained a continuous exhibit of fresh fruits throughout the exposition. In group 10, food products, the awards were 7 grand prizes, 41 gold medals, 57 silver medals, 54 bronze medals, and 21 honorable mentions.

Of these awards, 14 grand prizes, 7 gold medals, and 7 silver medals were awarded to the United States Department of Agriculture, 1 grand prize, 12 gold medals, and 4 silver medals to the State experiment stations, and a grand prize to the Association of Agricultural Colleges and Experiment Stations.

One grand prize was awarded to the Government of the United States, 1 to the Secretary of Agriculture, 4 to the Bureau of Animal Industry, 1 to the Bureau of Animal Industry and Weather Bureau, and 1 each to the Divisions of Agrostology, Chemistry, Entomology, Pomology, Statistics, Vegetable Physiology and Pathology, and Office of Experiment Stations. Gold medals were awarded as follows: Secretary of Agriculture, 2; Weather Bureau, 2; Division of Agrostology, Office of Experiment Stations, and the Director of Agriculture, 1 each. The Bureau of Animal Industry received 2 silver medals, and the Divisions of Soils, Entomology, Vegetable Physiology and Pathology, and the Office of Experiment Stations 1 each. United States exhibitors were awarded 7 grand prizes, 50 gold medals, 70 silver medals, and 6 honorable mentions for exhibits of dairy products, of which 4 grand prizes and 2 silver medals were to the dairy division of the Bureau of Animal Industry.

In the department of forestry a gold medal and silver medal were also awarded to the Secretary of Agriculture.

Tobacco was not included in any of the above groups, but in this, as in every other branch of the Department's exhibit, recognition by the jury of awards was most satisfactory. The share of premiums awarded to our American tobacco exhibit included the grand prize, 9 gold medals, 5 silver medals, and many honorable mentions.

## AFFILIATION OF ALLIED LINES OF WORK.

The development of the Department during the last few years has been rapid, and a study of the conditions existing therein leads me to believe that the time is at hand for a movement toward bringing together the related lines of work. It is fully recognized and appreciated, however, that whatever is accomplished in this direction must come through the harmonious action of all concerned and a full conviction that the opportunities for broader lines of work will be increased. In the past the tendency has been to segregate the work to such an extent as to make it difficult to bring about close cooperation along the broadest lines possible. There can scarcely be any doubt at this time that the best interests of the entire Department would be subserved by aggregation rather than segregation, but all advances along this line must be made in such a way as to give the broadest opportunity for the development of each Division without in any way interfering with its integrity or organization.

The future success of the Department will depend in large measure on each man being made to feel a personal responsibility as to the details of his work, and at the same time that he must lend his full support to matters of general policy which concern the Division of which he is a member and the Department as a whole. The broader plan, and one which it seems perfectly feasible to carry out, has for its object the arrangement of the work in such a close cooperative way as to bring the strongest support from every Division interested. Aside from the mere question of close cooperation and the possibility of undertaking many problems not feasible under the present plan existing in the Department, the intimate relation of the various allied groups will bring the investigators into more sympathetic union. Such a union can not help being advantageous to all concerned, and if recognized in the proper spirit, will go far toward advancing the best interests of the Department.

With a view of putting into practical operation a plan based on the principles outlined, four Divisions of the Department, closely allied by the nature of their work, have become affiliated and have perfected arrangements for a close cooperation and union along the lines set forth. To this association I have given the name of Office of Plant Industry.

## NEED OF LABORATORY BUILDINGS.

In my last Report an urgent request was made for new laboratory buildings. It was pointed out that the Department was conducting practically all of its important laboratory work in rented buildings, wholly inadequate for the purpose. It was further pointed out that the rent and other expenses connected with these buildings cost about $10,000 a year, and that a large part of this sum would be saved if proper buildings were provided. Plans were prepared and estimates obtained showing that the cost of a new fireproof structure, suitable for the Department's needs, would approximate $200,000, and a clause asking for this amount was submitted in my estimates to Congress. The item was approved by the Committee on Agriculture and was reported to the House, but was ruled out on a point of order.

I have again submitted estimates for a building costing not less than $200,000, and repeat my recommendation that this amount be appropriated. The very basis of the future growth and prosperity of our agricultural interests will depend upon what science is able to accomplish in the way of discovering principles and applying these principles in a practical manner. It seems fitting, therefore, that the very best facilities be furnished for this important and far-reaching work. As regards suitable laboratory buildings, the Department is far behind many State institutions, and it is earnestly hoped that this difficulty may be overcome in the near future.

## DIFFICULTY OF RETAINING EXPERT ASSISTANTS.

One of the problems which the head of this Department is compelled to deal with in every year of his administration is that occasioned by the difficulty of retaining in the Department service some of the most capable and efficient of its workers. It is true that the facilities for scientific investigation on an extensive scale are a great attraction to scientific men, and not a few of them in consequence continue in our service in spite of tempting offers from other sources. Nevertheless, in many cases it has proved impossible to retain some of our most useful men, and almost every year I am called upon to record the loss of one or more of our scientific staff, owing to my inability to give him a salary at all equal to that which is offered him elsewhere. It sometimes becomes necessary to engage assistance in the conduct of some of our important investigations at a rate of remuneration in excess of that paid to those under whose supervision they are to work and to whose initiative the investigation is due.

This year already three valuable workers have been lost to the Department, one having gone into the service of a foreign government and two others attracted by educational institutions. The difficulties attending the successful prosecution of our tobacco work for similar reasons have already been spoken of. The only remedy is for Congress to put it in my power to exercise a wider discretion in the matter of salaries to those intrusted with responsible positions in this Department—positions calling not only for scientific attainments, but for administrative ability, energy, good sense, and a wide knowledge of the economics of agriculture.

## EXPERIMENTAL FARM AT ARLINGTON.

Congress at its last session authorized this Department to take charge of part of the Arlington grounds lying east of the Georgetown and Alexandria road. These grounds are susceptible of being made productive and very attractive, but at the present time require grubbing, draining, surfacing, and fertilizing. This work is being vigorously pushed; drain tile will be laid during the coming year; $10,000 should be appropriated to carry on the work.

## SILK CULTURE.

The United States paid $32,479,620 in 1899 for raw silk, and $45,329,760 in 1900. This article is the product of the cheapest labor of foreign countries. We are demonstrating that tea can be grown probably in the Southern States, and that it can be gathered by colored children, whose parents are pleased with the additions these earnings make to the family income. This class of labor can pick mulberry leaves and feed silk worms. Industrious families in the State of Utah have for some years given much attention to this industry, and have skill that could be utilized in giving instruction in other States.

I respectfully suggest that $10,000 be appropriated by Congress to set research on foot regarding the production of silk, to the end that the money now paid to foreign labor be distributed at home. It is a question of utilizing labor which can not be employed in the more vigorous undertakings.

Respectfully submitted.

JAMES WILSON,
*Secretary.*

WASHINGTON, D. C., *November 24, 1900.*

# SMYRNA FIG CULTURE IN THE UNITED STATES.

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## INTRODUCTION.

That an article bearing this title should be prepared by an entomologist may seem at first glance unusual, not to say curious; but as is well known to those informed on the subject, and as will be readily seen by the readers of this article, the problem of establishing the Smyrna fig industry in the United States has been very largely an entomological problem.

Fig culture has never amounted to much as an industry in this country. Fig trees grow abundantly throughout the South and in California, having been introduced by the early French and Spanish settlers, and there have been more or less frequent importations since. As a domestic fruit, the fig is of considerable importance in all the Gulf and South Atlantic States. It is a common dooryard tree throughout this region. It has been grown with more or less success as far north as the lower Hudson River Valley, and where well cared for during the winter it will bear well for years, even at these northern limits. In the South figs are used almost entirely for household purposes. They are eaten fresh from the tree and are served on the table with sugar and cream. They are also stewed and made into puddings and pies, and are canned and preserved. In this section figs are occasionally, but seldom, dried for household use, as they ripen at the period of summer showers, which makes drying difficult. Much more of an effort to produce a salable dried fig has been made in California than in the South, especially during the last twenty years, and a greater success has been secured, probably on account of the drier climate. Fig trees were grown in California by the early Spanish padres, probably as early as 1710, and have flourished throughout the southern part of the State, one of the largest and most remarkable trees in America growing as far north as Chico (130 miles north of San Francisco), on the Bidwell place, where it was planted in 1856.[1]

[1] The writer saw this tree in 1898, and it is certainly one of the great horticultural curiosities of the country. It is 11 feet in circumference near the base of the trunk; branches have grown down into the ground and sent up new shoots, and the process has been repeated until a ground space of 150 feet in diameter is covered by this one tree, giving a dense shade over a space big enough to accommodate a large picnic party.

### ATTEMPTS TO GROW THE SMYRNA FIG.

After the early attempts to dry figs in California had progressed for some years it was gradually realized that with the varieties then growing it was impossible to arrive at a product which should compare in quality or commercial value with the Smyrna fig of commerce. As a result, in 1880 and 1882, Mr. Gulian P. Rixford, of the San Francisco Bulletin, imported into California, by the aid of E. F. Smithers, United States consul at Smyrna, and A. Sida, an American merchant in Smyrna, about 14,000 cuttings of the supposedly best varieties of Smyrna fig trees. These cuttings were widely distributed and were known as the "Bulletin" cuttings. This effort received wide newspaper notoriety, and much was expected of it, but when the trees came into bearing it was found that the fruit invariably dropped on or before reaching the size of a marble. Many explanations of this lack of success were made, the one generally accepted being that the Smyrna fig growers from whom the cuttings were purchased, fearing competition in the United States, had sent worthless varieties.

To test and remedy this matter, Mr. E. W. Maslin, of California, in 1885, planted Smyrna seeds taken from the best figs imported by the great wholesale grocery house of H. K. Thurber & Co., of New York, and presented to Mr. Maslin for experimental purposes. He grew in four years large and flourishing trees, the trunks of which had in 1889 reached a diameter of from 4 to 6 inches. These trees are still alive, and will be the subject of future study.

In 1886 Mr. F. Roeding, a banker in San Francisco and proprietor of the Fancher Creek Nurseries of Fresno, having become convinced that California could be made to grow as good a fig as could be grown in Smyrna, sent his foreman, Mr. W. C. West, to Smyrna for the purpose of investigating the fig industry on the spot. Mr. West remained in Smyrna four months and succeeded in securing several thousand Smyrna fig cuttings, as well as cuttings of wild figs and a few of such varieties as are grown for home consumption. He was watched by the people constantly. He was refused the sale of cuttings, and finally succeeded only by buying through a foreign resident, who was not suspected of any intention to export. After a journey of several months the cuttings arrived in Fresno in good condition and were planted in 1888 in the Fancher Creek Nursery, 20 acres being planted that year, 20 more in 1889, and in 1891 an additional 20 acres.

### ATTEMPTS TO GROW THE CAPRIFIG.

The importation at this time of the wild, or caprifig, cuttings was the most important step which had yet been taken toward the solution of the problem. This importation was due to the tardy recognition of the fact that the Smyrna fig, the standard fig of commerce, owes its peculiar flavor to the number of ripe seeds which it contains, and that these ripe seeds are only to be gained by the fertilization of the flowers of the Smyrna fig with pollen derived from the wild fig, or caprifig. Since time immemorial it has been known that in Oriental regions it has been the custom of the natives to break off the fruits of the caprifig, bring them to the edible fig trees, and tie them to the limbs. From the caprifigs thus brought in there issues a minute insect, which, covered with pollen, crawls into the flower receptacles[1] of the edible fig, fertilizes them, and thus produces a crop of seeds and brings about the subsequent ripening of the fruit. The careful investigations of Count Solms-Laubach and Fritz Mueller, in the early eighties, and later those of Dr. Paul Mayer, have shown that the varieties of the wild fig or caprifig are the only ones which contain male organs, while the varieties of the Smyrna fig are exclusively female. In the caprifig there is said to exist in Mediterranean regions three crops of fruit—the spring crop, known as "profichi," the second, as "mammoni," and the third, as "mamme," the latter remaining upon the trees through the winter. The fig insects (the Oriental species being known as *Blastophaga grossorum* Gravenhorst) overwinter in the mamme, oviposit in the profichi, develop a generation within it, each individual living in the swelling of a gall flower (a modified and infertile female flower), and issue from it covered with pollen, enter the young flower receptacles of the Smyrna fig, which are at that time of the proper size, and make an attempt to oviposit in the true female flowers, fertilizing them at the same time by means of the pollen adhering to their bodies The life history of the insect from that time on was not well understood, but the Blastophaga was known to occur again in the overwintering or mamme crop of figs.

In order to be certain that the right varieties of caprifigs and Smyrna figs had been imported and grown, Mr. George C. Roeding (the son of Mr. F. Roeding), in 1890, artificially fertilized his young Smyrna figs with pollen taken from the caprifig flowers, shaking the pollen out of the caprifigs and introducing it with a quill into the young Smyrna figs. Four Smyrna figs were produced as a result of this artificial fertilization, and in 1891 one hundred and fifty fruits were produced by using a glass tube drawn very fine at one end to introduce the pollen. After gathering a little of the pollen at the end of the tube Mr. Roeding inserted it into the orifice of the fig and then blew into it. As a result of this successful artificial fertilization, Mr. Roeding planted 20 more acres in 1892.

In the meantime Dr. Gustav Eisen, who as early as 1885 had published a pamphlet at Fresno entitled "The fig and its culture and growing, with especial reference to California," had been experimenting and

[1] The fig is not a fruit in the ordinary sense, but a flower and seed receptacle.

corresponding with European experts, and was probably the first scientific man to fully realize the importance of Blastophaga fertilization at a time when it was generally frowned upon. He had obtained from Solms-Laubach cuttings of caprifigs and Smyrna figs as well, had established these in the large nurseries of Mr. John Rock, at Niles, Cal., and in 1891 produced the same artificial fertilization of the Smyrna fig that had been produced by Mr. Roeding at Fresno. At Mr. Rock's place at Niles there are now growing several Smyrna fig trees of large size and a number of caprifigs, and Mr. Rock has accomplished the interesting result of grafting several varieties of the Solms-Laubach cuttings of caprifigs upon a single Smyrna fig tree. Dr. Eisen prepared and published in 1896 an important paper entitled "Biological studies of figs, caprifigs, and caprification," in the Proceedings of the California Academy of Science, series 2, Vol. V, pages 897-1001.

From the beginning of the work the Department of Agriculture had been thoroughly alive to the importance of its possible practical outcome, and by the close of the eighties the subject had become so well understood that it was deemed desirable to establish Smyrna figs and caprifigs in a number of localities in California and the Southwestern States, with the ultimate view that so soon as the proper host plants in the best possible condition should have grown to the proper size the importation of Blastophaga would be attempted. Thus, after consultation between Prof. H. E. Van Deman, then Pomologist, and Prof. C. V. Riley, then Entomologist, of this Department, caprifig cuttings were secured from Turkey and were distributed by the Division of Pomology in the winter of 1889-90. Comparatively few of the plantings from this distribution resulted successfully, but there are at several points in California and New Mexico a few large trees now living which have grown from this introduction. Much credit is due to the Division of Pomology, however, for these introductions, and had the persons to whom they were sent taken a uniform interest in the sendings and given them the best of care, the new industry just established would experience a more rapid growth than is at present possible.

### EARLY ATTEMPTS TO INTRODUCE BLASTOPHAGA.

The introduction of Blastophaga (fig. 1), the fig-fertilizing insect, was first attempted by private enterprise. Mr. James Shinn, of Niles, Cal., obtained the first specimens in July, 1891, but want of sufficient caprifigs for their propagation made the venture a failure. There was at that time only one caprifig tree on his place. The tree had just finished shedding, practically, all ripe caprifigs, and only a dozen ripe figs yet remained on the tree. There was absolutely no sign of a succeeding crop, and the hatching Blastophaga had no caprifigs in which to lay their eggs. As Dr. Eisen has remarked, "with only one caprifig tree, and that one bearing only one crop a year, this importation could not possibly have been a success." These first Blastophagas were imported with the help of a missionary in Syria. In 1892 Mr. George C. Roeding secured several consignments of figs containing Blastophagas from Smyrna, most of which arrived in good condition. On cutting a fig open hundreds of the insects emerged, flying around in a large Mason jar, in which he placed the fruit, and these insects were afterwards placed in a covered tree to note the ultimate result. Mr. Roeding also tried two other interesting experiments, but which were foreordained to failure; the one was the introduction of native Blastophagas from Mexico and the other of native Blastophagas from Hawaii. In 1890 the writer remembers to have seen some caprifigs received by the Division of Pomology from Turkey which contained living Blastophagas, but there was at that time no place known to the Pomologist to which they could be sent. Mr. Roeding from year to year continued his artificial fertilization of Smyrna figs at his Fresno place, and in 1897 a box of figs fertilized in this way was sent by Mr. Roeding to the Division of Pomology. The writer was shown some of these figs by Mr. W. A. Taylor, then acting pomologist, and their flavor at once convinced him, if he needed conviction, that the true taste of the Smyrna fig was there.

### SUCCESSFUL IMPORTATION BY THE DEPARTMENT OF AGRICULTURE.

Up to this time the Department of Agriculture had made no serious effort to import Blastophagas, but being convinced by letters from Mr. Roeding, and from statements received from the San Francisco Board of Commerce, in the late autumn of 1897, that probably the time had arrived for such an attempt, the writer was authorized by the Secretary of Agriculture to take charge of the work, and to attempt the importation and the establishment of the insect. He at first thought of having Dr. Eisen, so well qualified by virtue not only of his scientific attainments, but also on account of his special interest in this subject and his well-known investigations and conclusions, commissioned to visit Mediterranean regions for the purpose of collecting additional varieties of caprifigs, of sending overripe gall figs, and of bringing to this country, if necessary, an entire transplanted and healthy caprifig tree. He corresponded with Dr. Eisen on the subject, the latter secured a provisional leave of absence from the California Academy of Sciences, where he was at that time employed, and the details of compensation were arranged. It happened, however, that just at that time Mr. W. T. Swingle, a competent botanist in the employ of the Division of Vegetable Physiology and Pathology, was in South Europe on leave of absence, and it happened also that while studying at the Naples station Mr. Swingle had become interested in the subject of the fig, its origin and botanical varieties, and the phenomenon of caprification. This fact coming to the writer's attention, it was deemed advisable by utilizing Mr. Swingle's services to save for other purposes the funds which would have been required to send out a new man.

Another preliminary step undertaken by the writer was to visit California in the early spring of 1898 to inspect the points where Smyrna figs and caprifigs were supposed to be growing, so as to be able to decide upon the best point or points at which to attempt the establishment of the insect in the tolerably certain event of its successful introduction in living condition. Upon reaching Mr. Roeding's place near Fresno, the writer was at once assured, by the thriving condition of the trees and by their great number (nearly 5,000 in all, including 100

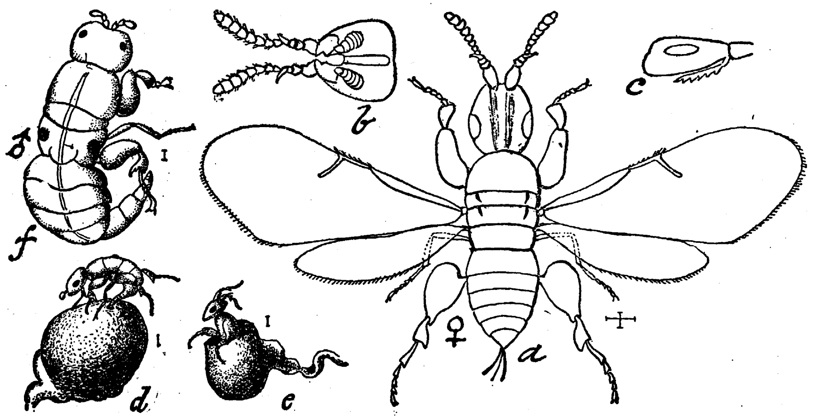
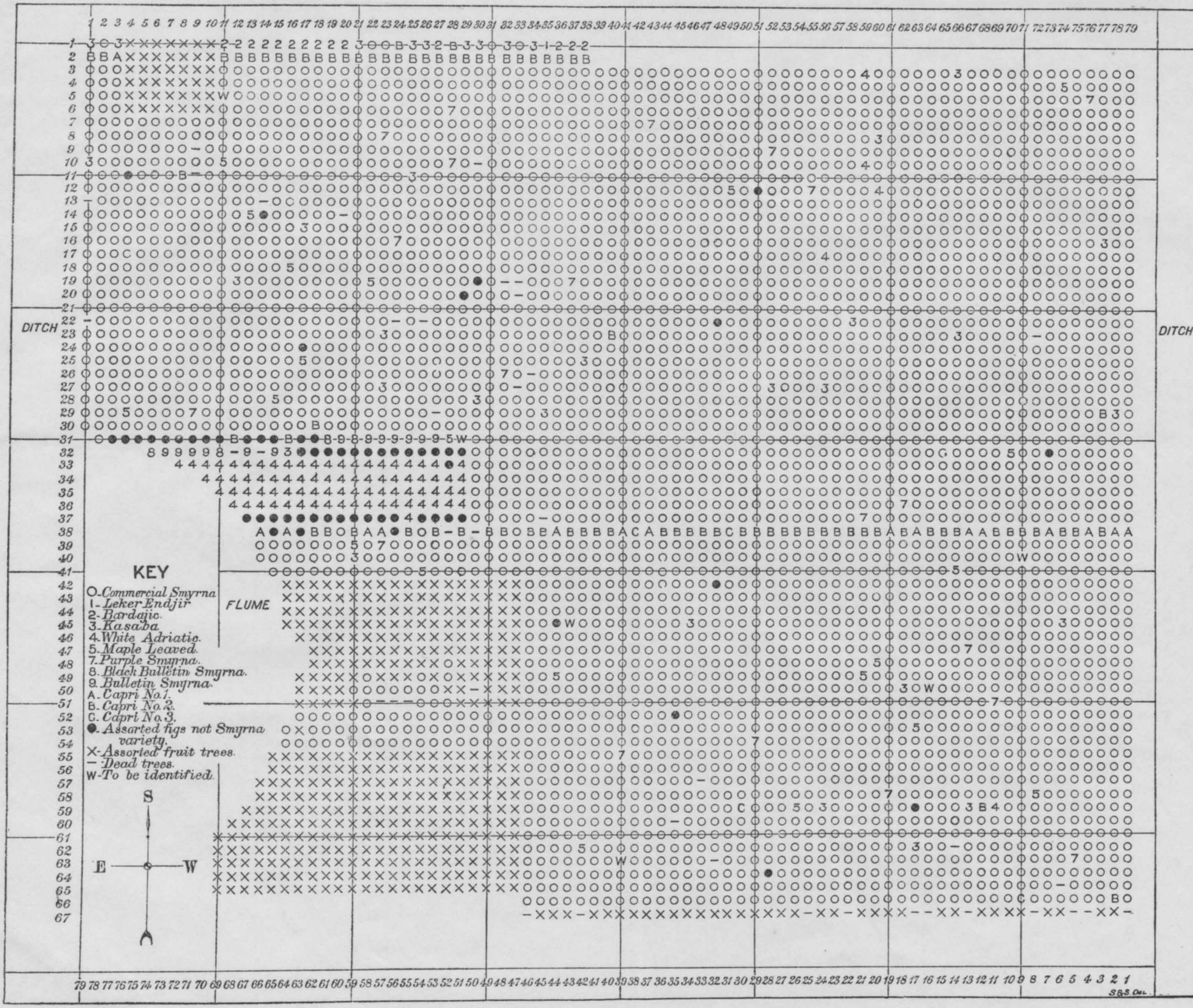



FIG. 1.—*Blastophaga grossorum:* *a*, adult female; *b*, head of same from below; *c*, head of same from side; *d*, male impregnating female; *e*, female issuing from gall; *f*, adult male—enlarged (after Westwood).

caprifigs), that no better place could possibly be found, or could be prepared in several years. A plat of this orchard is shown in Pl. I.

At some personal expense and on his own initiative, Mr. Swingle began in the spring of 1898 to send a number of caprifigs containing gall insects to the Department of Agriculture at Washington City for shipment to California, and made a careful study of the different varieties of caprifigs. The first shipment arrived at Fresno in April, 1898. It had been sent from Naples, the locality in which Dr. Paul Mayer had made his investigations. Mr. Swingle had adopted an ingenious and eminently successful method of packing. Each green caprifig was carefully and closely wrapped in tin foil, the end being covered with wax. On arrival at Fresno the female Blastophagas were seen to be emerging from the gall figs. In this first sending were quite a number of specimens of *Philotrypesis caricæ*, a parasite of the Blastophaga. Mr. Roeding readily distinguished between the female Blastophagas and this parasite, and destroyed all the parasites noticed. A caprifig




**PLAT OF THE ROEDING SMYRNA FIG ORCHARD NEAR FRESNO, CAL.**

[Location of the various varieties of Smyrna trees (open circles and figures) and the disposition of the Capri trees (letters). All trees are planted 25 feet distant from each other, and the entire orchard occupies an area of about 62 acres.]

tree was inclosed in a thin cloth tent and subsequent sendings of caprifigs were placed in this inclosure, and the Blastophagas were liberated.

Then a year elapsed without result. Either none of the caprifigs on the inclosed tree was stung by the Blastophagas or no larvæ developed, so far as Mr. Roeding could observe.

In the meantime Mr. Swingle had been transferred to the Section of Seed and Plant Introduction of the Division of Botany and commissioned as an agricultural explorer to work at the introduction into the United States of desirable plants. In the course of his work he went to Greece, and from there sent additional varieties of caprifigs to this country, which were forwarded to Mr. Roeding and planted under differing conditions.

In the winter he went to Algeria and sent other cuttings and one large caprifig tree. As the spring opened Mr. Swingle again began his sendings of caprifigs, packed as before, and which as before were placed by Mr. Roeding under the artificial inclosure. This time, as before, Mr. Swingle adopted the innovation of sending the winter generation of caprifigs instead of the spring ("profichi") generation, and to this important change is doubtless due more than to any other cause the success of these sendings, since, so far as can be learned, all earlier importations had been of the profichi generation. On March 31, 1899, six boxes of caprifigs were received by the writer and forwarded to Mr. Roeding, on April 5 one more box, and on April 6 the eighth and last. On April 6 the first boxes were received by Mr. Roeding. The fruits seemed to be in excellent condition. He cut several open and found them full of Blastophagas in the pupa condition. All of the figs were cut open and placed under the covered tree.

It must here be said that most of the persons connected with the work had little hope of the establishment of the fig insect by this method, on account of previous failures. It was tried because the opportunity offered and because of the variations referred to in the method of packing and the careful tenting of the single tree, in the hope that some might succeed in finding fruits of the right size for entering and for oviposition. Mr. Roeding, in acknowledging the receipt of the sending of March 31, and promising to cut them open and put them under the covered tree, said: "But I anticipate no results, and I do not think a success will be made of this matter until fig trees with the figs attached are sent out here during the winter months." Most of the figs shipped from Washington, D. C., on the 5th and 6th of April arrived at Fresno in a decaying condition.

In view of previous failures and this lack of confidence on Mr. Roeding's part, the pleasure of every one concerned in the results which followed can readily be understood. In the latter part of June, 1899, one of Mr. Roeding's men was engaged in gathering caprifigs and extracting the pollen for the purpose of artificially pollenizing Smyrna figs by means of the usual blowpipe process, and on the 23d of June he found one fig which contained evidences of the presence of the insect. On the 24th of June the tented tree was examined, and it was found that all the figs had dropped and shrivelled up with the exception of about 20, which were still green and plump, and which subsequent evidence showed contained developing Blastophagas. Other figs showing evidences of Blastophaga were found on outside trees, and by the end of June were found other wild fig trees upon which young figs, presumably the second crop, or mammoni, were beginning to develop. On the 30th of June a tree 1,500 feet away from the tented tree was found bearing two caprifigs containing galls and male insects.

About the middle of July Mr. Roeding found a few neighboring Smyrna trees which had been fertilized by the Blastophaga without any effort on his part.

About the end of August some of the caprifigs of the second crop (mammoni) had begun to come to maturity, but many young caprifigs were also present, and the insects entered them. By November 10, when Mr. Swingle visited Mr. Roeding's orchard, many swollen caprifigs were to be seen, which had been supposed to be the overwintering, or mamme, generation, but on that date and for a number of days subsequently thousands of the insects emerged, thus producing at least a partial fourth generation of the insect, a fact entirely unprecedented in the history of the species, so far as the writings of the European authors inform us. These entered at once the young individuals of this generation of figs, as could readily be observed at the end of November, when the writer visited the orchard, the minute wings of the insect being found adhering to the bracts on the outside of the fruit, while living males were still found in the older figs from which females had issued earlier.

### CARRYING THE INSECT THROUGH THE WINTER.

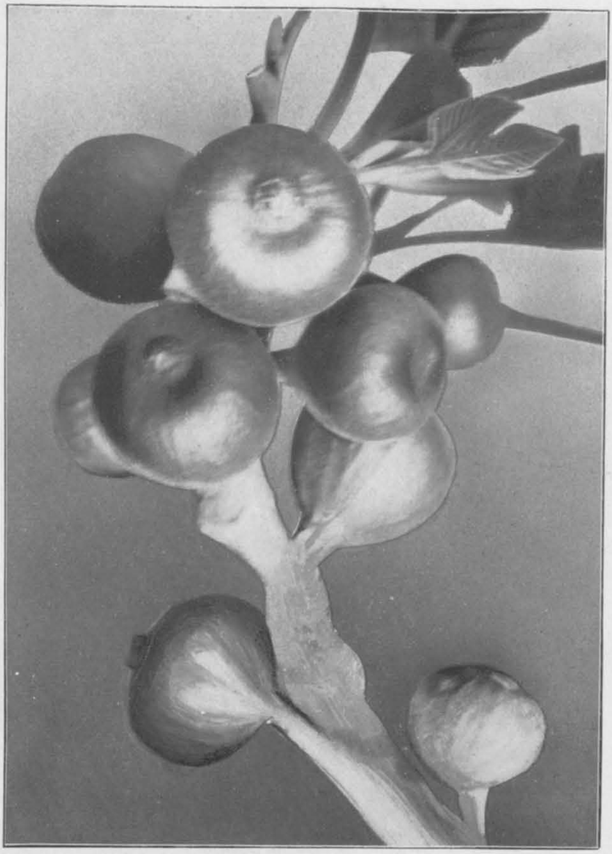
In November, for the purpose of protecting a goodly number of overwintering figs containing insects from possible freezing weather, Mr. Roeding built a cloth house 28 by 17 by 16 feet high, in which three trees were inclosed, in all bearing fully a thousand figs. At the time of the writer's visit (November 23–25, 1899) the cloth house was found to have been admirably designed. There was a high square framework of joists (Pl. II), with the canvas buttoned on over nails, so that a free circulation of air could be allowed and the trees could be entirely uncovered with a minimum of trouble in fine weather when no frosts were anticipated. The estimate of about 1,000 gall figs was confirmed and other trees outside the tent were found to carry a few caprifigs of the overwintering generation. Although Blastophagas had issued on the 10th of the same month, and although November 24

FIG. 1.—A 10-YEAR-OLD CAPRI TREE (ROEDING'S CAPRI NO. 1).

[Tree, in prime condition, as seen on March 30, when the young foliage was not yet fully developed; had been protected during the winter by a canvas tent, and the illustration shows the framework of the tent.] (Reduced from an original photograph.)

FIG. 2.—A 10-YEAR-OLD CAPRI TREE (ROEDING'S CAPRI NO. 2).

[Tree, in prime condition, as seen on March 30, when the spring foliage was not yet fully developed. In the background are the rows of Smyrna trees.] (Reduced from an original photograph.)



A BRANCH OF A CAPRIFIG TREE (ROEDING'S CAPRI NO. 1).

[Photographed on March 30, showing two winter figs or mamme (the two nearest the right side of plate), from which the hibernated Blastophagas are about to issue, and a bunch of spring figs or profichi (near the tip of the branch), which are in the receptive stage, that is, ready to receive the Blastophagas issuing from the winter figs.] (Reduced from an original photograph.)

was a bright warm day, with a temperature of 83° F., there were no signs of any insects issuing. One of the larger figs, in which the eye had opened, showing that the insects had probably issued on the 10th, was opened and was found to contain 1 dead female and 3 living males, the latter very lively. At this time some extremely small caprifigs were seen, and with a warm winter promised to be receptive to any Blastophagas which might subsequently issue. On the terminal twigs the buds seemed almost ready to swell.

From this time on the winter was passed without any occurrence worthy of especial note. About December 15 there was a frost of 29° F., and there were several light frosts later. On January 1, 1900, some of the large figs dropped from the tree under the cover and were found to contain fully developed male and female insects.

### AN ASSISTANT SENT TO FRESNO IN THE SPRING OF 1900.

As the time approached in the spring of 1900 for the issuing of the hibernating insects from the overwintering crop of caprifigs, the writer decided to station an expert assistant at Fresno during the entire season of 1900 to follow closely the biology of the insect, to watch and study carefully all conditions in order that, in case of possible emergencies, no opportunity should be lost through lack of expert entomological knowledge. Mr. E. A. Schwarz was chosen for this purpose, not only on account of the fact of his wide entomological knowledge and standing as a close observer, but also because he had been familiar with the subject of caprification for a number of years and was well posted in regard to the European literature. Mr. Schwarz arrived at Fresno March 11 and remained in California until early in November. He spent most of his days in the orchard, watched and assisted in all of the cultural features, made almost hourly observations upon the insects, and advised with Mr. Roeding and his assistants at all times. The following brief summary of the summer's work is drawn largely from Mr. Schwarz's correspondence and from an account which has been transmitted to the writer by Mr. Roeding:

Upon his arrival at Fresno, Mr. Schwarz found that two of the tented trees and some of the trees outside of the tent, all belonging to the same variety of capri trees,[1] bore about 400 apparently sound overwintering caprifigs. By March 18 many of the spring crop were seen to be as big as cherries, and with difficulty distinguishable from the smaller overwintering individuals. The larger overwintering

[1] There are three varieties of caprifig trees on Mr. Roeding's place, which, for want of better names, have been called Capri No. 1, Capri No. 2, and Capri No. 3. Pl. II (fig. 1) shows a 10-year-old Capri No. 1, and (fig. 2) a Capri No. 2 of the same age, both trees being in prime condition. Pl. III shows a branch of a Capri No. 1, and Pl. V shows the upper parts of a Capri No. 3.

specimens continued dropping, and all were found to be more or less affected with rot. To Mr. Schwarz it seemed probable that these larger individuals, which are pulpy in their character and which still contained full-grown insects, were not true mamme, but simply hibernating mammoni of the mammoni crop of 1899. In Europe this phenomenon is known; the belated mammoni are said even to stay over winter on the trees, maturing in the spring, and thus hardly to be distinguished from the genuine mamme in general appearance. In these larger specimens, which were taken to be belated mammoni, the insect was found all through the winter in the pupal or adult conditions, whereas Mayer and Solms-Laubach state that in Europe in the mamme the Blastophaga hibernates in the egg or larval condition. The issuing of the insects from these figs had evidently been prevented by the presence of a large amount of saccharine matter, and the greatest hope at this time was that the smaller figs, evidently the true mamme, would contain the insect in the proper condition to issue at the proper time. This generalization held not only for the figs upon the tented trees, but upon the others outside.

## THE EMERGENCE OF THE INSECTS IN THE SPRING.

The adult Blastophagas from these overwintering small figs began to issue March 28, and continued to do so for about five weeks. If the weather had been fair and warm this period would have lasted probably only three or four weeks, but bad days intervened, and the time was extended. Upon issuing, the adult female Blastophagas immediately entered the spring generation of caprifigs, which were in the proper receptive condition. Mamme, from which the Blastophagas were issuing or were about to issue, were transferred to other trees, with the result that on June 10 Mr. Schwarz wrote that at that time the total crop of good profichi was estimated at about 6,000. With knowledge gained later, a much larger number of good profichi figs could have been obtained if the transferring of mamme had been concentrated upon fewer trees, but since the orchard contained three varieties of capri trees, and since their qualifications were not well understood at the time, it was deemed best to distribute the insect over as many capri trees as possible. Some interesting practical information was thus gained—the Blastophaga emerging from the mamme oviposits preferably only in such profichi as are shaded, evidently not liking to work in the sun, and probably because the figs grown in the shade are cooler and fresher. The most valuable figs for this purpose seem to be those which grow on the small inner twigs which never reach the top nor the sides of the tree. Unfortunately, this inside growth in the orchard had been carefully trimmed out on most of the trees. This affords a cultural point of value for future experience. The average California horticulturist, judging from the writer's experience, finds his ideal of a fruit tree in its symmetrical and beautiful outline, but while this may be good for other fruits, it apparently does away with the bearing capacity of a fig tree of the Smyrna class.

### THE SPRING CROP OF CAPRIFIGS.

A natural spread of the insect was allowed to take place from two of the overwintering trees; but it was found that only a few neighboring trees could be caprificated in this way. The result of the transfer of the mamme to other trees was that a sprinkling of good profichi was gained, either good or poor, according to the variety or individuality of the trees, and of course also according to the number and quality of the suspended mamme. It appeared also that the mamme suspended previous to April 10 produced better results than those suspended afterwards, and it seemed that a caprifig tree in good condition requires at least 25 mamme to have a chance to be fully caprificated. This number, however, experience may lessen very greatly; in fact, at that time, while it was supposed that the method adopted of scattering the few mamme all over the row would not be favorable for a commercial purpose on account of the trouble in gathering the scattered crop, it has been found not to be so unfavorable after all. Many of the profichis, as above indicated, drop either by rubbing or by the action of severe winds, or by means of a disease which Mr. Schwarz terms "the ostiolum disease."[1] The insects themselves in this crop are, many of them, lost in numerous ways: They may issue as cripples and not be able to fly; they may be caught in spiders' webs; they may be caught in the sticky exudation from certain of the figs; they may lose their wings in attempting to penetrate, without success; they may die through entering figs which are too small, or several may enter the same fig; they may be blown away by the wind; they may enter figs which are too old. It was also noticed that the insects are very shy, and that when they issue from the mamme they drop to the ground on the slightest provocation. In these various ways, it was estimated that more than 50 per cent of all the Blastophagas issuing from the overwintering figs were lost, and of course in every subsequent generation the same thing occurred.

All of the profichi, or spring generation of figs, which had not been fertilized, continued to drop from the trees until June 3, and on June 10 for the first time there appeared to be a swelling up or puffing up of what appeared to be the ripest fertilized figs of this generation. These ripest figs within twenty-four hours became softer and assumed the pale olive-green color so characteristic of the ripening mamme. The characteristics of this generation of figs in different stages of growth are worth especial mention. When quite small they are globular,

[1] Mr. Schwarz subsequently decided that this disease is due to the presence of female flowers.

pale green, and delicately pruinose. Just before fertilization they are bright green, shining, and long stemmed. After caprification some of them become gradually more rounded or even transversely oval, dark green, hard and firm, and very pruinose. Just before ripening, viz, just before the issuing of the insect, the ostiolum opens and gradually assumes a more decided yellow color, and shortly after the first issuing of the Blastophagas the outer layer of scales becomes erect and quite stiff. As soon as the first batch of Blastophagas issues, the figs commence to collapse and appear shriveled, but other insects continue to emerge for several days afterwards. (Fig. 2.)

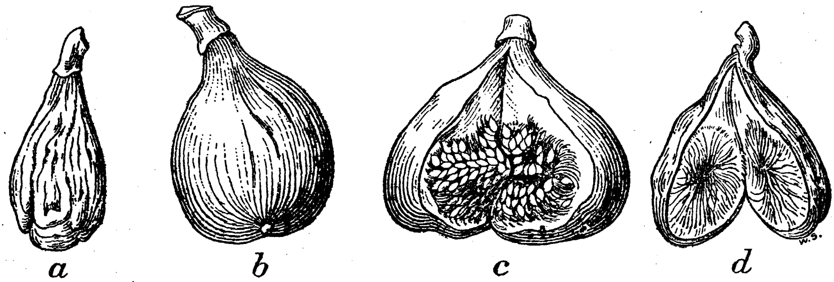



FIG. 2.—Caprificated and noncaprificated caprifigs (drawn from nearly dried-up specimens): *a*, outside appearance of noncaprificated fig; *b*, outside appearance of caprificated fig; *c*, interior of caprificated fig; *d*, interior of noncaprificated fig—all natural size (original).

## THE SECOND GENERATION OF BLASTOPHAGAS.

Blastophagas began to issue on June 11. After that date the daily temperature increased, and the Blastophagas commenced to issue at an earlier hour every subsequent day, until on June 24 they began to issue at 6 o'clock in the morning. No Blastophaga was observed to issue in the afternoon or evening. A fig gives out insects only for a short time each day, commencing again the following day, and continuing for four or five days, and perhaps longer. The number of Blastophagas issuing from one fig each day is extremely variable, but reaches in some figs 50 or 60, perhaps more, which come out with a rush. The whole flight for each day does not last more than three or four hours, so that after 10 o'clock in the morning on June 24 very few specimens could be seen.

Although the issuing from the overwintering crop lasted over four or five weeks, fully 95 per cent of the profichi generation gave out all of their contained insects in two weeks.

## CAPRIFICATION.

As soon as the first Blastophagas of the second generation were seen issuing on June 11, Mr. Schwarz commenced hand caprification, and succeeded in performing this function for about 20 trees.[1] The next day

[1] In Pl. V, at the lower left-hand side, is represented a twig of a Smyrna tree bearing young figs, which show the striking difference between specimens caprificated by

a number of workmen joined him, and by June 15 and 16 a force of 9 men was at work. The active work of caprification was carried on from the 11th to the 20th of June. It was early found that the estimate of 6,000 healthy profichi was altogether too small, and the entire force was kept very busy. An estimate was made that it would have taken at least 17 men, working assiduously for a week, to caprify one-half of the orchard of approximately 4,000 trees, namely, 10 men to do the picking and stringing, 5 to do the distributing and suspending, and 2 to carry the strung figs from headquarters to the distributers. The expense in wages for half the orchard would be in the neighborhood of $125.

The appliances necessary for caprification were found to be a number of stepladders, especially small ones; fruit baskets, or light boxes, for the collection of the figs; shallow wooden trays, into which the picked figs are laid for inspection; harness needles and raphia fiber, for stringing; scissors and sharp knives, for cutting the ends of the raphia; gasoline, for washing the needles; a bucket of salt water, for the frequent washing of the hands; poles, short and long, for hanging the strings of caprifigs; hooks and crotches, to support the poles; flags, sticks, and labels, to mark the caprified areas on trees.

Finding only brief directions in the literature, Mr. Schwarz decided at first to devote 10 caprifigs to the average Smyrna tree, but the number was increased to 12, 14, 16, or even 20, wherever the trees were above the average in size. Recaprification with a smaller number of figs, varying from 2 to 10, was carried on at intervals of from three to five days, as far as the provision of profichi lasted. A second recaprification would be desirable; but for this purpose another variety of caprifigs, bearing either earlier or later figs, will be necessary. The system adopted was about as follows: At 6 o'clock in the morning all hands turned out and proceeded to pick over the caprifigs (either by hand or by pulling them off with a bamboo pole fruit picker), assembling finally at headquarters, where the figs were laid out in trays for inspection. This inspection was to eliminate the worthless figs, and to keep only those which were pretty sure to give out a good supply of insects. Doubtful ones were kept separate and were suspended on experimental

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the Blastophaga (the two figs on the left side of the branch) and not caprificated specimens (the three figs on the right side of the branch)—nearly natural size (photographed July 2).

The large figs along the right side of the plate are nearly ripe caprificated Smyrna figs (reduced from natural size), the cut specimens representing that stage where the stems of the female flowers, greatly thickened, secrete the largest amount of saccharine matter (photographed August 20).

The small twig with figs at the upper left-hand corner of the plate represents the earlier mammoni crop of caprifigs (Roeding's Capri No. 1), the large fig at the tip of the twig being nearly ripe and about ready to give forth the winged Blastophaga females—natural size (photographed August 20).

trees. During this inspection the stringing of the figs began, and all hands joined in this tedious, dirty, and slow work. One or two figs at each end were strung with a strong needle upon a bit of the raphia fiber. After stringing 20 or 30 the needle and fingers become covered with the sticky, milk-like fluid which exudes from the stems, and the washing of fingers and needle becomes necessary. After stringing a couple of thousand of the figs each operator became aware that this milk possesses some poisonous quality. The tips of the fingers become sore and burn like fire. They aggravated this evil at first by washing the hands in concentrated salt water, so that they could proceed with the work only with considerable pain. The Japanese laborers simply rubbed their hands with dust, and probably this is the best way of getting temporarily rid of the milky stuff. Each string of raphia was then hung over a pole, which was suspended at some little distance from the stringers. The method of stringing and inspecting is illustrated in Pl. IV, fig. 1. After about 600 figs were strung the poles with their strings of figs were taken up, and the distributing party of five men started with the figs into the orchard, where the figs were suspended on the branches or wound about the twigs. This is illustrated in Pl. IV, fig. 2. Two rows of trees were thus caprified at a time, and the shaded portions of the trees were chosen. When the supply of figs was exhausted flags were planted on the row at the tree where the work stopped, and the distributers returned to headquarters to help the stringers until another batch was ready for distribution. In this large orchard the distributing party had to walk at least 10 miles a day, each row being almost half a mile in length. The plan of throwing the strings into the trees was tried, but was not very successful.

In this way about 18,000 profichi figs were distributed, and more than 1,300 Smyrna trees were successfully caprified. Then also to the number of trees which were caprified by the transfer of figs must be added an unknown number of trees from which a crop of Smyrna figs was to be expected by the natural spread of the Blastophaga. At this time the loss of Blastophaga by spider webs was observed to be very great. Mr. Schwarz estimated that several hundred thousand specimens were lost in this way.

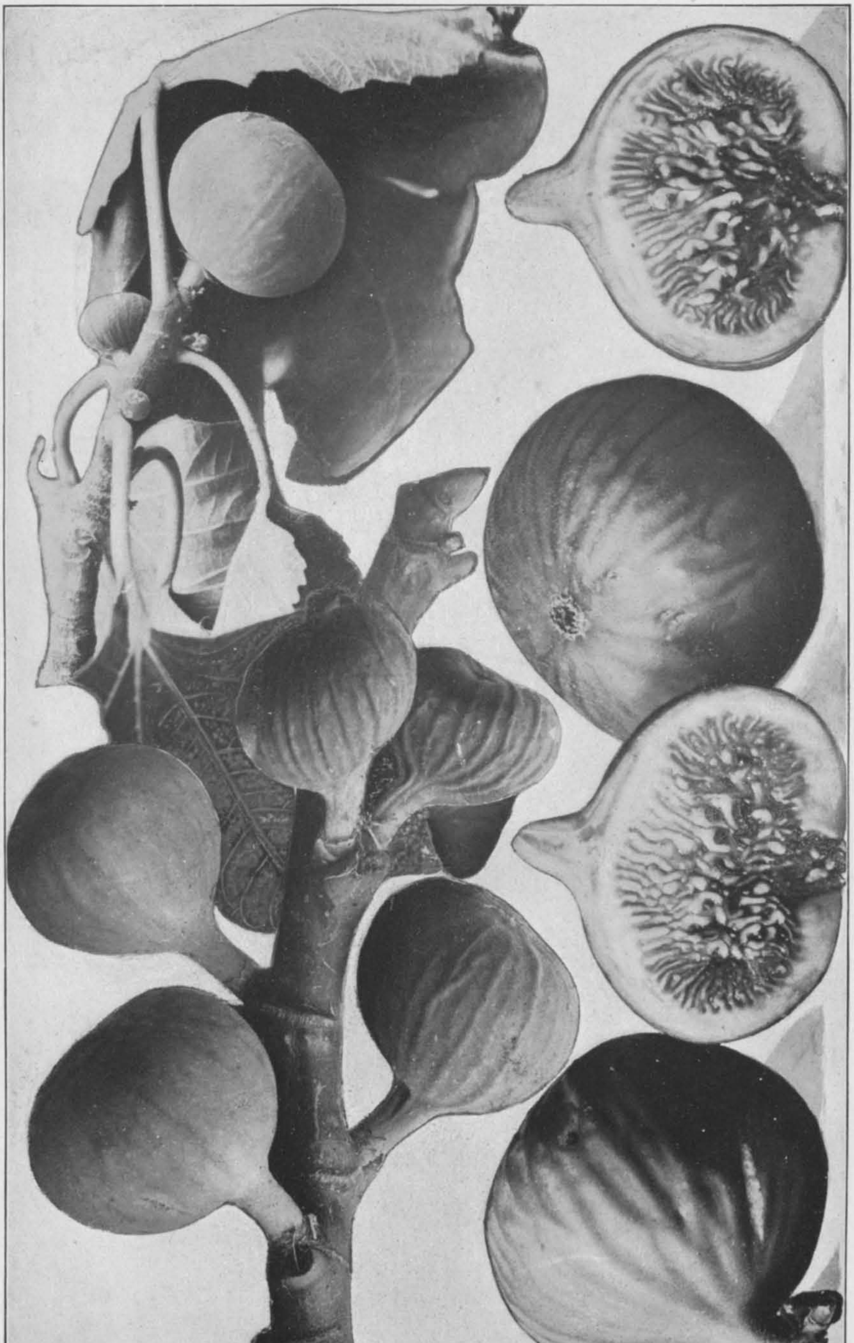
The effect of caprification on the young Smyrna figs becomes readily visible within a few days, and is illustrated by the figure of a twig at the lower left side of Pl. V. Before the Blastophaga enters the fig the latter is transverse and strongly ribbed, as shown in the three figs on the right side of the twig. A few days after fertilization the fig swells up and becomes rounded and sleek, as shown by the two specimens on the left side of the twig. The figures along the right side of the plate represent (on a somewhat reduced scale) the "botanically"

FIG. 1.—CAPRIFICATION.

[The process of sorting, examining, and stringing the profichi figs, preparatory to their distribution upon the Smyrna trees. For further details, see page 92.] (Reduced from a photograph taken June 13.)

FIG. 2.—CAPRIFICATION.

[Distributing the profichi figs upon the branches of the Smyrna trees. For further explanation, see page 92.] (Reduced from a photograph taken June 13.)



CAPRIFICATED AND NONCAPRIFICATED FIGS.

[For explanation of plate, see footnote, pages 90 and 91; also page 92.]

ripe Smyrna fig, the cut specimens showing that stage where the female flowers secrete the largest amount of saccharine matter.

The first figs were caprified on June 11, and the first ripe one dropped to the ground on August 2. By August 8 quite a number had dropped, but what may be termed real dropping did not begin until August 15, and ripening continued from that time on well into September, the whole period covering from four to five weeks. This gradual ripening is the most serious drawback, since the figs must be gathered every other day. This is an expensive affair in California, even with the cheap Chinese laborers employed.

### HARVESTING AND DRYING.

As just stated, as the figs dropped they were collected every other day by laborers who went through the orchards provided with receptacles for collecting. This continued from August 8 for four or five weeks. No fertilized Smyrna figs were observed to drop to the ground prematurely. A great loss of insects, however, is occasioned by two or more (as many as five) Blastophagas entering the same fig, whereas only one is necessary for thorough fertilization. Another loss was from the Blastophagas entering the figs which were beyond the receptive stage, and which were found dead between the scales of the ostiolum. As the figs ripened another loss became apparent, many specimens turning orange yellow and a small area remaining hard and wrinkled. The bright orange color renders such figs easily recognizable, and if the defective spot is small, no great injury results. Moreover, during the expansion period of the figs many of them crack. The expansion due to the abundant secretion of saccharine matter is so powerful that the delicate skin of many figs, and, unfortunately, among the finest and largest, can not stand it, and the fig splits in two, usually across the ostiolum. Sometimes it splits into three parts and opens like a rose. If the split does not extend very far the fig is not rendered worthless, but if it extends across the surface the fig is lost. The loss caused by birds is also very great, especially by the California house finch or linnet (*Carpodacus mexicanus obscurus*). Mr. Schwarz found that these birds never nest on the fig trees, but on the shade trees along the roads, on the garden trees in the vicinity, and on the willows and cottonwoods along the ditches. They do not fly far away from their nesting places, and there was consequently little damage done in the central part of the fig orchard. Along the borders, however, hardly a single good fig was harvested on account of these birds. He advises, therefore, that a Smyrna fig orchard should not be planted in the vicinity of large shade trees or orange groves. Souring of the figs was not noticed in the early part of the season, but began later to a limited extent when showers occurred. When the Smyrna figs ripen the ostiolum opens wide and remains open so that a match can easily be inserted and often moderate-sized insects can enter and feed on the sugar. Some of them are caught in the sticky sap and die within the fig. When the figs are ripe and fall, ants and beetles of the genera Notoxus and Carpophilus enter in this way. Wasps and other insects, notably among them a species of Blapstinus, eat holes through the skin if the figs are allowed to remain on the ground longer than a day or two.

On account of these and other losses, only about one-half of the crop of Smyrna figs was gathered this year in Mr. Roeding's orchard. The entire crop was estimated by Mr. Schwarz at from 12 to 15 tons of good figs on the trees, all resulting from the inhabitants of less than 450 winter figs!

It was found then that there are not less than seven or eight well-distinguished races or varieties of Smyrna fig trees in the Roeding orchard. Caprificated figs of all these varieties were obtained, and while that variety which has been called the "Commercial Smyrna" fig proved to be better adapted for drying than the other varieties, few would deny that some of the latter were of more delicate flavor than the commercial variety. Whether or not practical methods of drying these figs can be found must remain for later experience. Some of the more striking of these varieties are shown on the accompanying plates.

Pl. VI, fig. 2, illustrates the "Black Bulletin," which is one of the Smyrna figs introduced by the editor of the San Francisco Bulletin.

Pl. VII, fig. 1, represents the "Purple Smyrna" fig, a tree of the most beautiful shapely outline, closely resembling from a distance the Chinese umbrella tree. Fig. 2 of this plate shows the White Bardajic Smyrna, the most readily distinguishable variety on account of its pear-shaped fruit. This may prove to be of exceptional value.

Pl. VIII, figs. 1 and 2, represent 10-year-old "Commercial Smyrna" trees in full bearing, the fruit, however, showing very indistinctly in the illustration on account of its color.

It may also be of interest to state that the second crop of the San Pedro figs has been successfully caprificated by the Blastophaga.

After the collection of the figs they were transferred to the drying ground, dipped into a boiling brine made by dissolving 3 ounces of salt to a gallon of water, and then placed on trays, the time of drying varying from two to four days, according to the weather. The dipping of the fig is supposed to bring the sugar into the skin, hasten the drying, and make the skin pliable. After the figs were dried they were placed in sweat boxes holding about 200 pounds each, where they were allowed to remain for two weeks, to pass through a sweat. The only other treatment they received before packing was to wash

FIG. 1.—UPPER PART OF CAPRIFIG TREE (ROEDING'S CAPRI NO. 3), SHOWING ABUNDANT CROP OF CAPRIFICATED SPRING FIGS (PROFICHI).

[The photograph taken on May 23, and Blastophagas commenced to issue from the figs about June 11.] (Reduced from an original photograph.)

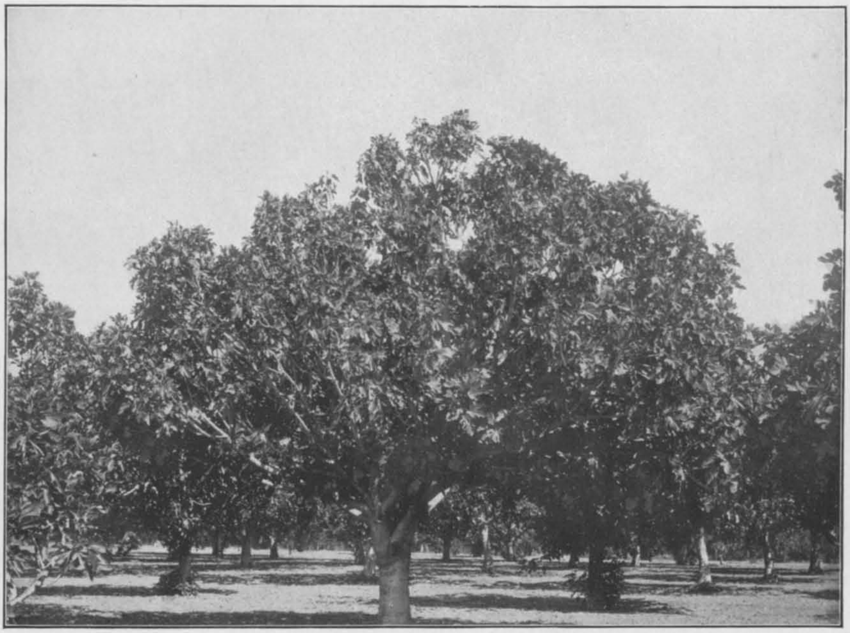


FIG. 2.—THE "BLACK BULLETIN" FIG TREE (15 YEARS OLD).

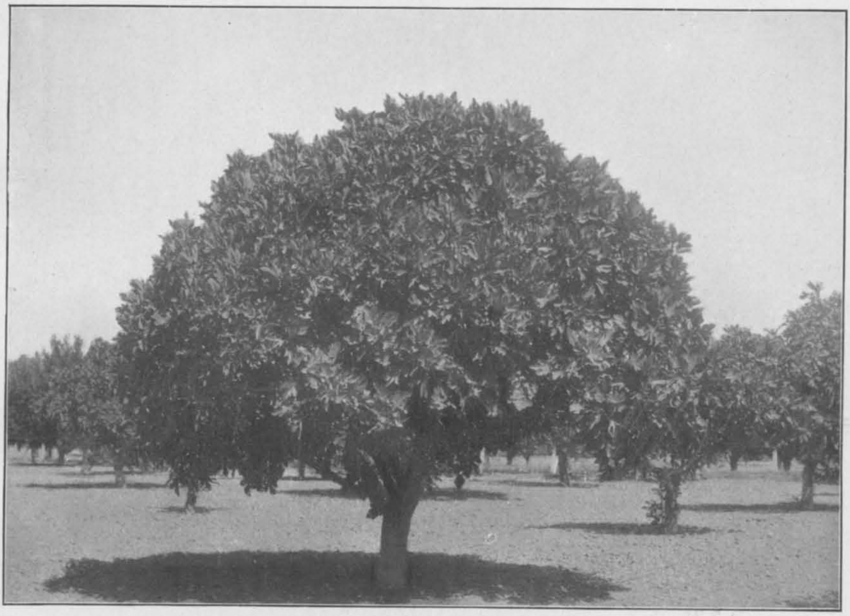


FIG. 1.—THE "PURPLE SMYRNA" FIG TREE (10 YEARS OLD).

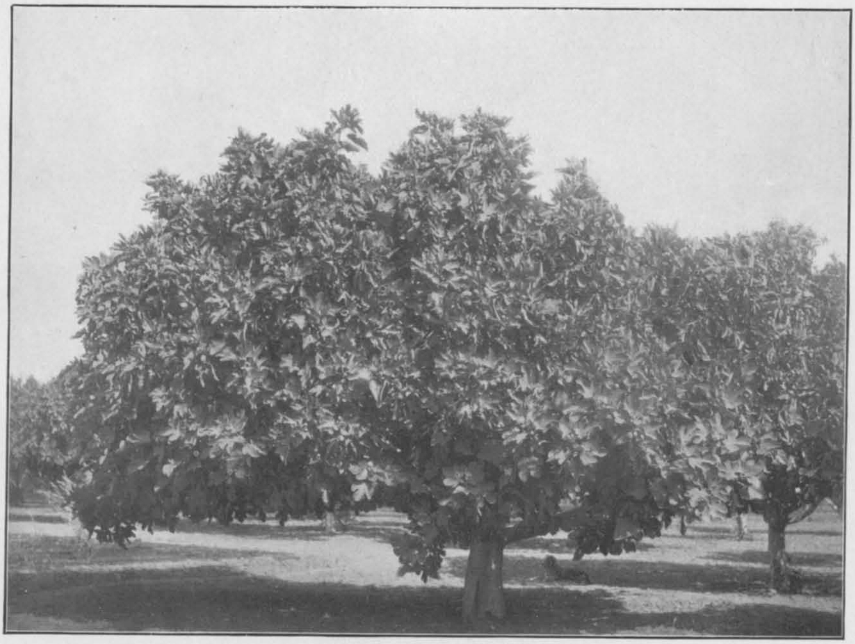


FIG. 2.—THE WHITE "BARDAJIC" SMYRNA TREE (15 YEARS OLD).

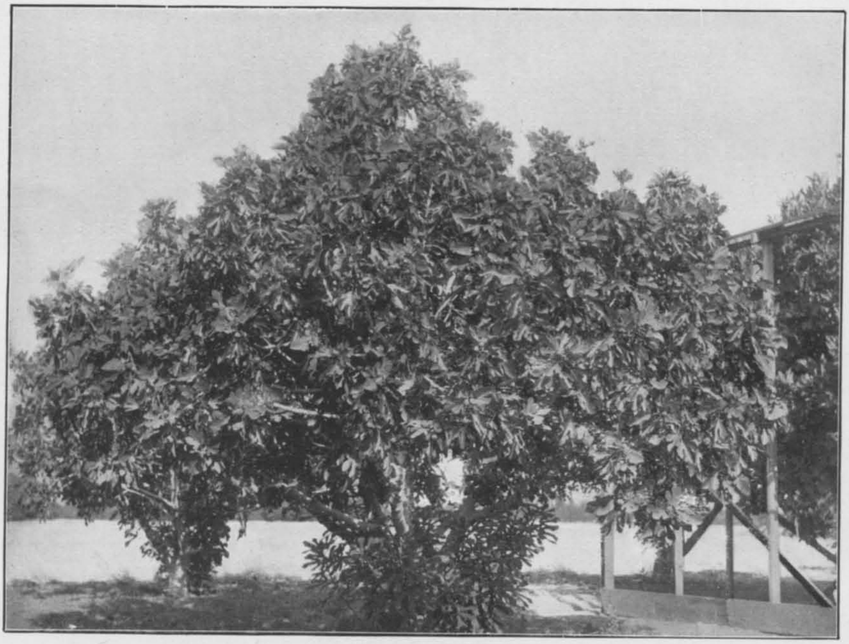


FIG. 1.—THE "COMMERCIAL SMYRNA" FIG TREE IN FULL BEARING (10 YEARS OLD).

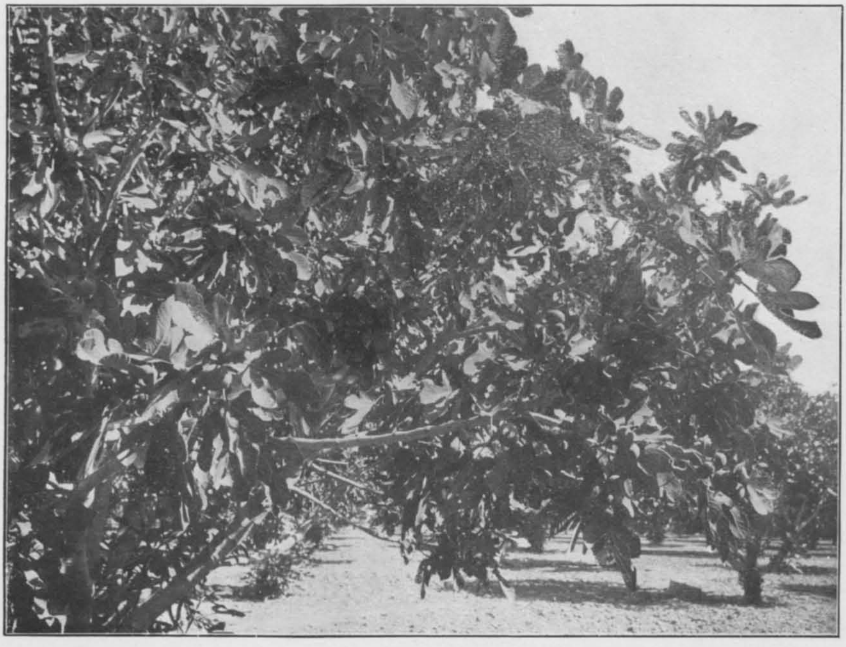


FIG. 2.—PARTIAL VIEW OF THE "COMMERCIAL SMYRNA" FIG TREE IN FULL BEARING (10 YEARS OLD).

them in cold salt water, for the purpose of removing all dirt, and figs which were overdried or improperly fertilized (called "dummies" by Mr. Roeding) rose to the top when placed in the solution.

### PACKING.

More than 6 tons of the product, dried in the manner just described, were put up in half-pound, 1-pound, and 10-pound boxes in layers, and 1-pound cartons. They were taken to one of the leading packing houses in Fresno in sweat boxes, the same size as is used for raisins and other dried fruits in California. In the height of the season from 200 to 300 hands are employed in this packing house. The neat appearance of the women and girls, and the cleanliness observed in the handling of the fruit are features of California packing houses, which are certainly not equaled in similar institutions in Smyrna.

The figs were first graded by machinery, a long tray with small holes in one end, which increased in size toward the other end, being used for this purpose. The three largest sizes were packed, the smaller grades being simply pressed in 50-pound boxes without packing. After grading, the figs were passed through a closed trough of boiling hot water, an endless chain with buckets attached being used for this purpose. This thoroughly cleansed the figs and softened them so that they could be easily handled. The work of packing was done exclusively by women and girls, and the splitting of the figs was practiced as in Smyrna, a short-bladed knife being used for that purpose.

The layer figs were packed in 10-pound boxes with three and four layers in a box, these layers being the finest and largest figs. The cartons consisted of 1-pound packages wrapped in waxed paper and packed 10 to the box. The largest figs in this mode of packing are known to the trade as 6-crown, the next in size 4-crown, and the smallest size 3-crown. Each brick of figs, as it is called, is neatly wrapped with colored ribbons, making when finished a very attractive package.

### QUALITY OF THE PRODUCT.

Chemical analysis made by Professor Hilgard, of the University of California, showed that figs submitted to him by Mr. Roeding contained 1.42 per cent more sugar than the best imported Smyrna figs. Samples which the writer has received are of exceptional edibility. The flavor is delicious and precisely comparable to that of the imported figs, except for the lack of the slight acidity noticed in those ordinarily bought on the market, and which is of a rather disagreeable quality. Wholesale grocers to whom the writer has shown samples speak with strong approval of their quality, and there seems little doubt that a great and profitable trade in figs of this grade can readily be gained in the United States.

THE SECOND CROP OF CAPRIFIGS.

When the caprification of the Smyrna figs began, about the beginning of the second week in June, the second crop of caprifigs, in which only could the life round of the Blastophagas be maintained, was just beginning to appear, but in such small numbers as to cause a real break in the succession of crops. The advance individuals were readily entered by the second generation of Blastophagas, but it was deemed rash to depend solely upon the chances that when a goodly number of the second crop should be ready there would still be enough issuing Blastophagas to enter them; so a trip to Niles was undertaken early in July, and six profichi were carried back to Fresno. At this place a colony of Blastophagas had been successfully established in April, eighteen overwintering caprifigs having been taken there from Fresno. Between July 21 and 27, Blastophagas issued from two of these Niles caprifigs at Fresno. At Niles, however, they did not hatch out until the first week in August, and at the latter place very few of the second crop (mammoni) figs had developed. Thus, in case the break between the spring and second crops at Fresno becomes so marked another year that Blastophagas issuing from profichi figs are unable to find mammonis in which to oviposit, the later issuing Blastophagas may be brought in their profichi from Niles, and the succession of generations maintained. Thus all caprifigs of the second crop at Fresno, which developed from the buds subsequent to July 5 (the issuing period of the profichi generation of Blastophagas having been June 11 to July 5) did not get any insects (disregarding here the artificial importation from Niles). They kept on developing, vigorously, however, on into September, but in the meantime the first mammoni generation of Blastophaga developed from the comparatively few mammoni figs which were in a receptive condition between June 11 and July 5, began issuing August 13, and continued to issue on into September. This practically means that there were two generations of Blastophaga covered by one generation of caprifigs. Judging by the observations of last year (and it will be remembered that the Blastophagas issued in great numbers the second week in November), there are unquestionably four generations of Blastophaga at Fresno, contrary to preconceived ideas. Moreover, Mr. Schwarz writes that from a study of the dates given by Dr. Paul Mayer he has not the least hesitation in asserting that at Naples, Italy, there are also two mammoni generations of Blastophaga. Mayer's dates, September 4 and October 28, when he observed the mature insects, plainly indicate two generations, for it is very improbable, judging by Mr. Schwarz's careful observations the past summer, that the period of issuing of one generation of Blastophaga should occupy eight weeks. Dr. Mayer came near assuming two mammoni generations of Blastophaga, but preferred to cling to the three-generation theory, and tried to explain away the difficulties by the assumption of early and late trees. At Fresno there is no such thing as early and late trees. One variety of caprifig is five or six days later than the other, but there is no greater difference.

These second-crop figs, whicn were not entered by the Blastophaga, dropped just as did the noncaprified Smyrna figs, most of them dropping when very young. The changes which take place in the second-crop figs which have been stung are practically the same as in the Smyrna figs. The final expansion is not very marked, but is accompanied by a noticeable change of color, from a rather dark olive green to a beautiful sea green. At the time of issuing of the insects the ripening mammoni are globular or very slightly elongate, white, and not particularly soft, but they turn quite soft and yellowish on the second day after the issuing of the first insects. On the fourth day they usually drop, having acquired a dirty ochreous color. From the majority of them a few female Blastophagas still issue when the fig is on the ground. All of these figs are of remarkably small size, only a few specimens being a little larger than a large cherry. In consequence of their small size, the number of Blastophagas issuing from each is correspondingly small. No exact count was made, but there are hardly more than 100 galls in the largest figs and less than 50 in the smallest. The females issue, as with the profichi generation, in the forenoon. At first they come out about 10 o'clock and continue until nearly noon, but as more figs become active the insects come out earlier, and by the 1st of September they commence to issue at 7.30 and continue until about 10 o'clock.

The time occupied in the development of this early generation of Blastophagas in the second crop of figs was practically two months, since from June 11 to July 5 the issuing profichi generation of Blastophagas were ovipositing in the advanced second crop of figs, and the issuing of their offspring occupied the interval from August 13 to about September 15.

### FOURTH GENERATION OF BLASTOPHAGAS.

The later generation of Blastophagas in the second crop of figs, that is, the fourth generation, beginning from the overwintering mamme, proved to be a mere repetition of the first mammoni generation, taking place in what is unquestionably the same crop of figs. The first set of figs of this crop came just in time to catch the profichi Blastophagas (June 11 to July 5). The next set did not get any of the insects (July 5 to August 13). That which was receptive subsequent to August 13 caught the early mammoni generation of Blastophaga, and the figs becoming receptive after September 12 did not get any insects. The interesting point about the later mammoni generation of Blastophaga is that it consists of what may be termed a recuperation of the

Blastophaga to a larger number of specimens after the great breakdown suffered by the scarcity of available second-crop figs during the first mammoni generation. On September 16 Mr. Schwarz found that he had many thousands of inhabited figs of the later mammoni generation of Blastophaga (fourth generation). On September 13 he cut open two average-sized mammoni and found the interior of normal form, pale yellowish in color, and crammed full of well-developed galls, in which the Blastophaga larvæ were already plainly visible without a magnifying glass.

On September 17 the offspring of the profichi Blastophagas brought down from Niles commenced to issue. The duration of the first mammoni generation commencing on July 21 was therefore only fifty-eight days, a trifle shorter than the average duration of the Fresno insects. By September 24 almost every available fig in proper condition had been taken possession of by these insects, thus forming a second mammoni generation four and one-half weeks later than that formed by the Fresno Blastophagas.

On the 29th of September Mr. Schwarz visited Niles and examined the situation there. He concludes that there is every reason to suppose that the Blastophaga can be permanently established at that point, and that as a station for stocking or restocking other places with Blastophaga the importance of Niles can not be overestimated. The value of the ability to transfer the insect to localities having another climate can not fail to be very great. Thus, the importation of the Niles profichi to Fresno resulted in a mammoni generation of Blastophagas which is intermediate between the two Fresno mammoni generations, and this no doubt will increase or did increase the chances of producing a greater supply of healthy wintering figs. The value of a similar transfer of winter figs in April, or even later, will be still more important, as it will produce later profichi insects at Fresno.

### POSSIBLY ONLY TWO TRUE CROPS OF CAPRIFIGS.

As the autumn advanced it was noticed that no break could be seen in the fig crops between the mammoni and the expected mamme, such as undoubtedly occurred between the profichi and the mammoni. Solms-Laubach says that in Europe there is no sharp distinction between mammoni and mamme, and that those of the former crop which do not mature in the fall remain as mamme over winter. The question arises, then, Are there two separate crops of figs or are the hibernating figs, known as the mamme crop, simply all late developing and overwintering mammonis? Mr. Schwarz observed that there is not the slightest difference in the mode of growth and location on the twigs between the mammoni and the mamme, which both develop on the new growth of the season. The first crop of figs develops on the old growth, and is accompanied by a liberal sprouting of leaves.

Toward the end of May the appearance of the second crop is also accompanied by the appearance of a set of leaves, but after that time no new leaves sprout and the leaf buds on the trees in October plainly belong to the first crop of the next year. If there were a third crop of figs would there not also be a third crop of leaves?

### ISSUING PERIODS OF BLASTOPHAGA.

To sum up, the issuing periods of Blastophaga during the season, both in California and in Naples, Italy, are shown in the following table, which will doubtless make perfectly clear the somewhat complicated conditions described in previous paragraphs:

*Dates showing the issuing periods of Blastophaga.*

| Generation. | Issuing periods of Blastophaga in California. | | | Issuing periods of Blastophaga in Italy. | |
|---|---|---|---|---|---|
| | Fresno. | Fresno, imported from Niles. | Niles. | Naples. (According to P. Mayer.) | Dates given by Eisen. |
| Mamme | Mar. 28–Apr. 25 | ........ | ........ | End of March to April. | April. |
| Profichi | June 11–July 5 | July 21–July 27 | Aug. —Sept. 3 | June 22–July 27 | June. |
| First mammoni. | Aug. 13–Sept. 12. | Sept. 17–Sept. 28. | ........ | Sept. 4 ........ | |
| Second mammoni. | Oct. 5 ........ | ........ | ........ | Oct. 28 ........ | October. |

Dates of issuing are of great value when we consider the question of the practical handling of the insect. Those above given may be modified by subsequent experience or by differing weather conditions, but they will probably remain approximately constant.

### ABSENCE OF PARASITES.

A very fortunate aspect of the situation in California at the present time is the absolute absence of parasites of the Blastophaga. Elsewhere the Blastophaga has its parasites, and the very important one in South Europe, Philotrypesis, although introduced in the original importations which Mr. Swingle sent from Naples in the spring of 1898, and present in great numbers, was killed off so far as possible by Mr. Roeding, and in fact the whole importation failed. The Algerian importations in the spring of 1899, from which the success of the experiment dates, appeared to contain no parasites whatever, and in the whole course of his summer's work at Fresno Mr. Schwarz never saw one, so he feels sure that it does not exist there. Nor did he see any trace of the work of the Nematode, which is said by Italian writers to be a constant inhabitant of caprifigs and edible figs. Unless, therefore, parasites of Blastophaga are introduced with wild figs from Lower California, Mexico, or Florida, it is unlikely that *Blastophaga* *grossorum* will have parasites in California. It has, however, other unimportant natural enemies like the Chrysopa and ladybird larvæ, but its greatest natural enemies are found in spiders. Webs constructed across the surface of a leaf or between the figs and the nearest leaves, geometrical webs between branches, simple runways spun along branches or between branches, all catch many Blastophagas. Those across the surface of the leaf seem the most destructive, and Mr. Schwarz found frequently from 100 to 150 specimens of Blastophaga caught in one of these webs. One little wolf spider was observed to catch Blastophagas as they emerged from the figs. Certain birds extracted the galls from ripening caprifigs.

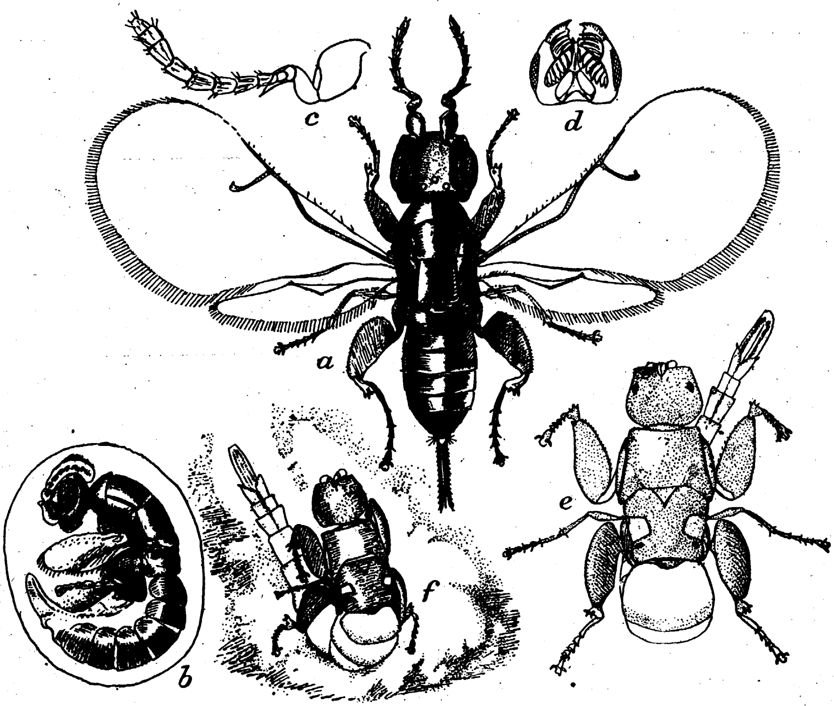



FIG. 3.—*Blastophaga grossorum:* *a*, adult female with wings extended, seen from above; *b*, female not yet entirely issued from pupal skin and still contained in gall; *c*, antenna of female; *d*, head of female from below; *e*, adult male; *f*, the same—all greatly enlarged (original).

## LIFE HISTORY OF BLASTOPHAGA.

So far, we have referred to the life history of the fig-caprifying insect only in the most general terms. The illustration (fig. 1) which is given of the insect in the early part of this article is a copy of an old one drawn by the famous English entomologist, Prof. J. O. Westwood, and which was published in the Transactions of the Entomological Society of London, 1882, plate iv, in part. It is an interesting figure, and illustrates rather well the difference between the male and the female. It shows the peculiar mouth parts of the female, which enables her to gnaw her way through the tough seed-like gall, and shows also the male in the act of fertilizing the female and the female in the act of issuing from the gall. It is, however, incorrect in some of the rather important structural details, as will be seen by comparing it with fig. 3, here given, which has been drawn under the writer's supervision from living specimens reared at this office and in Cali-

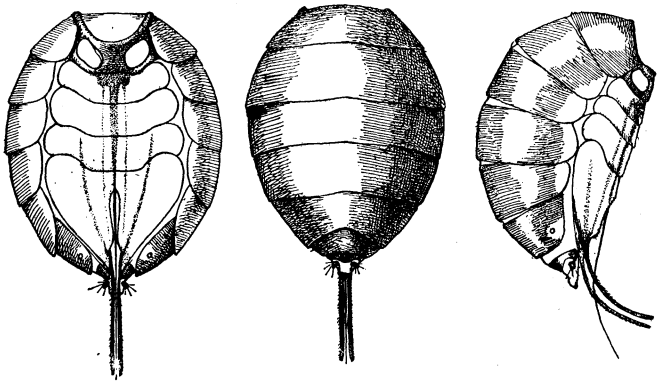


FIG. 4.—Abdomen of Blastophaga, female, viewed from beneath, from above, and from the side—enlarged (original).

fornia. The entomologist will at once note especially the difference in the details of the thorax in both males and females, and especially will the difference in the length of the abdomen of the male be seen. (Figs. 4 and 5.)

The male is always wingless. It has no ocelli, and its compound eyes are greatly reduced in size. The fact that the male rarely leaves the fig in which it has hatched might almost be inferred from these facts of winglessness and partial blindness. When this wingless male issues from the seed-like gall in which it is contained, it seeks a female gall in the interior of the same fig, gnaws a small hole through its cortex, inserts its extremely long, almost telescopic, abdominal extremity through the hole, and fertilizes the female. The female subsequently, with her powerful jaws, gnaws the top of the gall off and emerges, crawling around the interior of the fig and eventually forcing her way through the ostiolum, almost immediately seeking for young figs, which she enters, and should the fig entered prove to be a caprifig, lays her eggs at the base of as many male flowers as she can find, and then dies. Should the fig entered, however, be a Smyrna fig, either through the fact of the caprifig from which she issued having

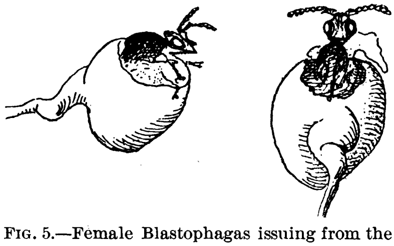


FIG. 5.—Female Blastophagas issuing from the galls—greatly enlarged (original).

been hung in the branches of a Smyrna fig tree, or from the fact that she has flown to an adjoining Smyrna fig tree, she walks around among the female flowers seeking for a proper place to oviposit, discovering eventually that she has made a mistake, but, nevertheless, probably trying to find a proper place for oviposition by thrusting her ovipositor in here and there. It is this futile, wandering search, covered as her body is with pollen from the caprifigs, that produces the extensive and almost perfect fertilization of the entire number of female flowers.

### THE EGG.

The egg when seen in the ovary is very long and slender, but when found in the fig it is less than three times as long as broad, almost regularly elliptical in shape, white and slightly shining, with a delicate petiole of about 1½ times its length. On dissecting a male flower into which the egg has been inserted by the female Blastophaga, it will be found to have been pushed in transversely to the axis of the flower nearly to the center, with the petiole reaching out to the cortex. Its dimensions are, length, exclusive of petiole, 0.092 mm.; width, 0.046 mm.

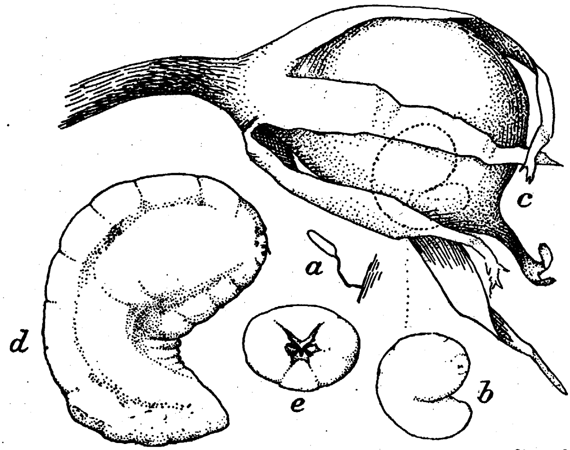



FIG. 6.—*Blastophaga grossorum: a*, egg; *b*, young larva; *c*, outline of same in gall; *d*, full-grown larva; *e*, mouth of same—enlarged (original).

### THE LARVA.

The young larva is a delicate little creature curved upon itself and showing no visible segmentation, much as indicated in fig. 6, *b*. It takes many days development of the caprifig before the larva becomes visible with certainty without the most careful observation under a strong lens. The first sign which indicates that one is watching the larva and not the sap in the gall is the visibility of two brownish spots, which are without doubt the mandibles of the larva. When these spots become visible, with a very powerful hand lens (one-fourth inch Tolles triplet), the larva is more than two-thirds grown and the segmentation of the body has become noticeable. It is a very difficult thing to dissect the larva out of the gall without crushing it, but it can be accomplished with care by the aid of dissecting needles. No casting of the skin has been observed. The full-grown larva presents the appearance indicated in fig. 6, *d*, and occupies the position in the gall shown by the dotted lines in fig. 6, *c*. With the growth of the larva the gall at the base of the male florets becomes hard, and greatly resembles a seed, turning light brown in color.

### THE PUPA.

The male and the female pupæ each occupies a greater portion of the interior of the gall, and the advanced female pupa, almost ready to emerge, presents the appearance indicated in fig. 7.

### DURATION OF THE EARLY STAGES.

This is a point upon which it is very difficult to secure exact data. From the table of dates of the issuing periods printed on page 99, the duration of a generation, excepting, of course, the hibernating generation, seems to average between sixty and sixty-eight days, say, sixty-four days. It seems certain that more than fifty days are given to the larval stage. Oviposition takes two days, or perhaps longer, and the last larval stage

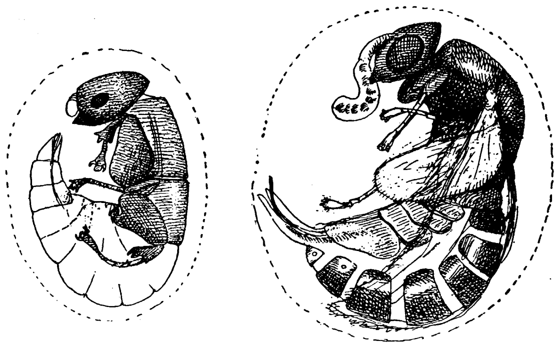


FIG. 7.—*Blastophaga grossorum:* Male and female pupæ in galls—enlarged (original).

with the pupa stage, and what may be termed the immature imago stage, lasts only a few days. All of the long intermediate period is occupied by the immature larval stages unless there should prove to be a prolonged egg state, which is very improbable. These three stages seem paralleled by the three outwardly visible changes undergone by the fig, and which have been described in preceding paragraphs. The first swelling of a freshly stung fig, about four days after the entering of the insect, probably marks the hatching of the egg. The long intermediate stage of slow almost imperceptible growth is identical with the duration of the larval stage, and includes also the pupal stage. The final and sudden expansion of the fig always marks the issuing from the galls (but not from the fig) of the male imagos. In the hibernating generation the duration of the final stage is greatly prolonged. On March 15 Mr. Schwarz found the insect in fallen overwintering figs as larva, pupa, immature imagos, and occasionally mature male imagos, and this lasted until March 28 or later. The same state of affairs was found in figs sent to the writer by Mr. Roeding as early as February. It seems probable that before a sudden drop in temperature occurred at any time subsequent to the middle of October the insect would hibernate in all of the different stages in which it might happen to be at the time, because it is the presence of the insect which makes the fig adhere to the branch during the winter.

### THE OUTLOOK FOR THE NEW INDUSTRY.

The success of the present season's work at Fresno indicates that in very many localities in the interior valleys of California good crops of Smyrna figs can be raised, and there is little doubt that many persons will at once start orchards of Smyrna fig trees, with the proper sprinkling of caprifigs. This statement holds not only for California, but unquestionably for good fruit-growing regions in New Mexico, Arizona, and Texas. Mr. A. M. Gildea, at Del Rio, Tex., for example, has now several 10-year-old caprifig trees in good condition, growing from the Department of Agriculture sendings of 1890. This experience, however, does not enable us to make any predictions of value regarding the Gulf region. Experiment stations in Louisiana and more Southeastern States, and fruit growers in those States who can spare the land and the time to conduct the experiment, should by all means try it on a small scale. We possess very little information which will enable us to predict with any certainty the outcome of such experiments. The climate of these regions differs so radically from that of the Roeding place at Fresno that unquestionably not only will the caprifigs and Smyrna figs have different seasons, but the insect will be considerably altered in its life-history periods, even if it should flourish in such parts, and that itself is a fact of which we can not be absolutely certain. It is for these reasons that we earnestly advise that the experimental work at first should be done upon a small scale. A few trees only of several varieties of caprifigs and of Smyrna figs should be started, so that much valuable land need not be occupied. After these trees come into bearing the work of a season or two will indicate the probabilities of success, and then, if the results warrant further outlay, more trees can be started. We are sure that the insect will flourish in a dry climate where there is little frost. Persons residing in such locations can begin planting at once with a reasonable certainty of a profitable outcome. In all other regions planting should be done experimentally and in a small way. The work which has been done so far in California will be followed up by this Department. Further observations upon the Blastophaga will be made, and its habits will be carefully followed during succeeding generations, while the Section of Seed and Plant Introduction promises to secure cuttings of all possible varieties of caprifigs, and to distribute them at proper points, so that in the emergency of the dying out of the insect at one place it can be reestablished at another point within our own territory.

Aside from the manipulations connected with the operation of caprificating the Smyrna trees (see pp. 90–93), it may safely be assumed that the management of the Blastophaga, for the propagation of the species, will not cause any trouble throughout the year, provided that a sufficient number of capri trees are planted in the proper way. Each of the three Asiatic varieties of capri tree represented in the Roeding orchard has peculiar advantages and disadvantages, all of them, however, being valuable varieties. The mode of planting them in two long rows (as shown in the plat of the orchard in Pl. I) caused considerable work as often as the Blastophaga made its appearance outside of the figs. For the present, it is recommended that the capri trees be planted in a grove by themselves, so that the insect will have the greatest possible chance of spreading by natural means.

The Smyrna fig stands in the same relation to other varieties of figs as the Washington navel orange stands to ordinary varieties of oranges, and its superiority as a dried product over all other varieties which develop without caprification can no longer be questioned. The annual output of Smyrna figs is estimated to be from 12,000 to 15,000 tons, and these figs sell at wholesale in the New York market at from 10 to 20 cents per pound, while the best grade of California figs, as hitherto raised without the assistance of the Blastophaga, does not bring more than 75 cents for a 10-pound box, and when the Smyrna figs arrive it is difficult to sell California figs at any price. The successful production of the Smyrna fig described in the foregoing pages practically awakens a new industry for the United States.

In 1894 we imported 13,440,604 pounds of Smyrna figs, the valuation of which was $698,894. After the adoption of the tariff law of 1897, which fixed an import duty of 2 cents per pound, shipments to this country decreased, and the importations for 1898 amounted to 7,992,544 pounds, the valuation of which was $382,784. The following year the importations increased to some extent, and the price was higher. In that year we imported 8,535,967 pounds, and the valuation was $504,800. It seems very probable that in the near future these importations will practically be stopped, as our whole country will be supplied with home-grown dried figs. The transportation charges from California, before the construction of a trans-isthmian canal, will keep the prices high in the Eastern States, but it is safe to say that with the better character of the product the total consumption of dried figs will increase. But this feature by no means comprises all the possibilities of the industry. America will compete with the Mediterranean countries in the open markets of the world. The character of the product, even of this first year's crop, shows it to be superior to the Oriental product, both from chemical analysis and from expert opinion. Experience gained this year assures a much better result next year, not necessarily in the quality of the fruit itself, but in methods of drying and packing and of producing an attractive product for the market. Cleanliness in packing, prevention of the disgusting worms so often found in the imported Smyrna figs, and other similar points will be carefully attended to by American packers. At present there are by no means enough trees growing in California to bring about this result; but the right varieties will be planted by the thousands during the coming year, and in four or five years will be producing substantial crops.

# AMPLIFICATION OF WEATHER FORECASTS.

By Alfred J. Henry,
*Professor of Meteorology, Weather Bureau.*

## GENERAL REMARKS ON WEATHER FORECASTING.

The purpose of this paper is to promote the understanding of Government weather forecasts and to encourage the making of local predictions by persons whose working hours are spent for the most part in the open air.

The time at the disposal of the forecast official of the Weather Bureau at the central office in Washington City for the purpose of forecasting probable weather changes, cold waves, and severe storms is about thirty minutes in the morning and forty at night. It is impossible in this short time to do more than express the character of the anticipated changes for each State or district east of the Rocky Mountains in any but the most general terms. The local or State forecast official, on the other hand, is concerned with but a single district. He is at liberty to amplify the national forecasts or to put forth a statement of his own, in which the anticipated changes may be given in as much detail as the conditions seem to justify.

Persons who use the forecasts constantly should cultivate the habit of carefully noting the weather changes in their respective localities, especially the sequence in which such changes occur, for it is only by acquiring a knowledge of local weather signs that they can use Government forecasts to the best advantage.

## DAILY WEATHER FORECASTS AND THEIR TERMINOLOGY.

The Weather Bureau issues from its Washington office two forecasts daily, at about 10 a. m. and 10 p. m., respectively. The observations on which the forecasts are based are made at 8 a. m. and 8 p. m., Eastern standard time. The morning forecast covers a period of twenty-four hours, beginning at 8 p. m. of the day on which the forecast is issued. The first twelve hours of the period is always referred to as "to-night;" the second is given the name of the day to which it may refer. Thus, "Fair to-night and Tuesday" would be the form of a forecast issued at 10 a. m. Monday. "To-night" in this case would begin at 8 p. m. Monday and run until 8 a. m. Tuesday, while Tuesday would end at 8 p. m. of that day, not midnight, as some might suppose. The forecast made at 10 p. m. is for a period of forty-eight hours. A forecast made on Monday night would take the form "Partly cloudy Tuesday and Wednesday." This forecast, it will be observed, does not apply to the night of either Tuesday or Wednesday.

"Fair weather"—that is, the absence of rain or snow—is indicated by several terms. The first of these is the word itself. It may be used singly or be preceded by the word "generally." "Generally fair," as used by the forecaster, is less positive than "fair" alone. It signifies that the probability of fair weather over the whole district and for the entire period is not so great as when "fair" alone is used.

"Partly cloudy" is another expression that is used when the indications favor cloud but no precipitation. "Threatening" is used when in the judgment of the forecaster the weather will be overcast and gloomy, with the appearance of rain or snow at any moment, yet a measurable amount of precipitation is not anticipated.

A forecast of "rain" or "snow" may be expressed in various ways. In the late fall, early spring, and the winter season it is most commonly indicated by the single word "rain" or "snow," as the case may be, thus: "Rain to-night." And when used in this form it is expected that the rain will continue for several hours. In other seasons of the year any one of the following terms, viz, "local rain," "showers," and "thunderstorms," may be used. Local rain and showers are almost identical in meaning. The word "thunderstorm," of course, carries its own significance. Any one of these terms indicates that the rain will not be general over the whole State or district. The most marked feature of precipitation in the warm season, as compared with the cold, is its unequal distribution over relatively small areas. A shower cloud may form and pass over several counties or it may dissipate within 5 miles of its origin. Indeed, we may say that it is only in exceptional cases that general and continuous rains fall in the summer season. In some seasons local rains may occur in some part of a State every day of the month, but the science of meteorology is not yet far enough advanced to delimit the path of a local shower and the exact time of its occurrence.

Forecasts of local rains, showers, or thunderstorms indicate that the conditions are favorable for the occurrence of precipitation in the district and for the given period.

"Clearing" is a word frequently used which carries a broader meaning than the word itself signifies, viz, the occurrence of precipitation in the early part of the period; thus "Clearing to-night" would indicate that rain or snow, whichever might be falling at the beginning of the period, would cease shortly thereafter and that the weather would be clear during the greater part of the time.

FIG. 1.—CIRRUS CLOUDS.

[Light, feathery clouds that float at an elevation of 4 or 5 miles above the earth's surface. When in the form of plumes with frayed and torn edges increasing cloudiness and rain or snow are indicated.]

FIG. 2.—CIRRUS, MERGING INTO CIRRO-STRATUS CLOUDS.

[A transitional form often seen when rain or snow is approaching. The cloud layer gradually thickens until the sky is obscured.]

FIG. 1.—FAIR-WEATHER CUMULUS CLOUDS.

[These clouds, it should be observed, have level bases and rounded tops without the dome-like structure of figures—a type of cloud often seen after a spell of rain.]

FIG. 2.—CIRRO-CUMULUS CLOUDS.

[Small round masses of clouds usually at an elevation of 4 or 5 miles above the earth's surface. These clouds are typical of fair weather.]

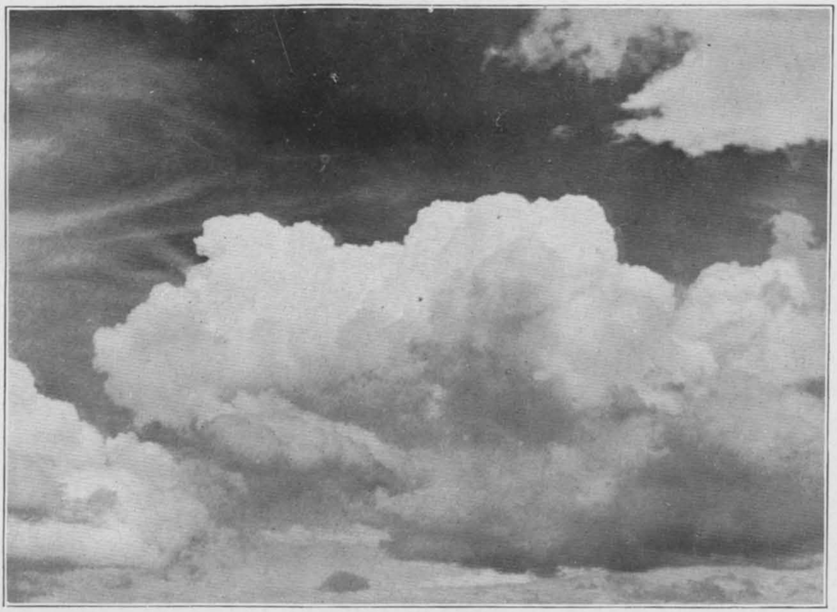


FIG. 1.—CUMULUS CLOUDS.

[Cumulus clouds, as in the above, illustrating the formation of a central core of ascending warm air, generally precede local rains or thunderstorms by a few hours.]

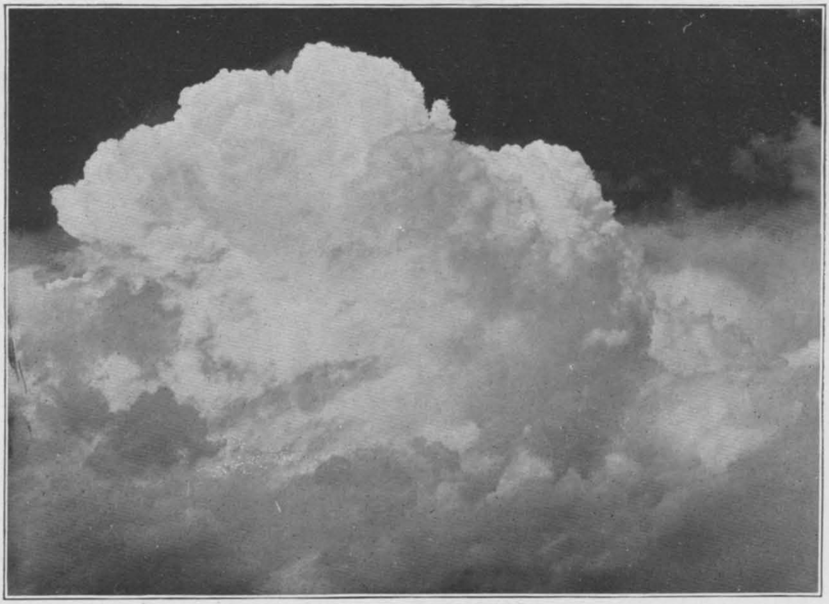


FIG. 2.—NEAR VIEW OF LARGE CUMULUS CLOUDS.

[The small detached clouds on the lower left-hand margin of the cloud are almost invariably seen in advance of thunderstorms. Cumulus clouds, like those shown, rarely give rain at the point of observation, since their prevailing drift in these latitudes is eastward.]

### LOCAL SIGNS OF FALLING WEATHER.

Persons whose working hours are largely spent in the open air soon become familiar with the changing aspects of the sky and the condition of the atmosphere as to its moisture content, viz, whether relatively dry or humid. If careful observers of natural phenomena, they note also the shift of the wind and the sequence of weather which follows. In this way and without special effort a fund of weather wisdom is soon acquired which needs only to be properly correlated in order to serve a most useful purpose. The greatest advantage will naturally accrue to the individual who reads and accurately interprets, not only the Government forecasts, but also the local weather signs. In the remainder of this paper the local signs of falling weather will be briefly described.

#### CLOUDS.

Clouds are formed from the moisture that is always in the air, in varying quantities, even over the desert. Like the air itself, the moisture that is within it is invisible so long as it remains in the form of a gas. When a mass of air is cooled by any means whatsoever a portion of its water vapor is condensed and becomes visible—a mist or cloud is formed. A familiar illustration of cloud formation in nature is afforded when a current of warm, moist air strikes a cold mountain. The colder surface of the mountain condenses some of the moisture that is in the air, forming a cloud which frequently obscures the top of the mountain and floats away in the prevailing winds. This simple phenomenon indicates to an observer on the leeward side of the mountain that a warm, moist current of air, with probably rain or snow, is approaching. In some parts of the world the formation of a cloud cap on a mountain top is not an indication of precipitation, yet in the majority of cases it is believed to be a reliable prognostic of falling weather. In general, the formation of cloud after a clear spell is the first sign of coming rain. Unfortunately, there is no definite interval between the time of the first appearance of clouds and the occurrence of rain. Rain may not fall for several days after the first appearance of clouds, and, on the other hand, it may begin within two or three hours after the first cloud makes its appearance.

The various cloud forms generally observed in the United States, with their especial significance, are given in Pls. IX, X, and XI.

#### THE TEMPERATURE AND MOISTURE OF THE AIR.

An increase in the amount of moisture in the air is indicated in various ways. It is especially noticeable to the senses when coupled with a high temperature. Man does not need a thermometer to tell him that the air is oppressively warm, nor a hygrometer to tell him that there is an unusual amount of moisture present. A pitcher of ice water on a hot summer day is not a bad sort of hygrometer. The pitcher is naturally cooler than the surrounding air, and consequently some of the water vapor in the air is condensed and collects on the outside of the pitcher. It will be remembered that water vapor changes to the liquid state when the air is cooled below a certain point. The principle illustrated by the pitcher of ice water is repeated on a grand scale in nature every time rain or snow falls. First, there is the cooling of the air and the formation of cloud, the latter being composed of minute particles of water; second, there is the further cooling of the cloud mass, so that its particles join to form small raindrops, which fall to the earth by their own weight. When a rain cloud strikes the top of a mountain, rain does not necessarily fall, but small mist-like particles of water are deposited on the relatively colder surfaces of the rocks and other objects on the mountain sides and top. These particles coalesce and run down the sides of the objects on which they are deposited precisely as frequently happens on a pitcher of ice water on a warm, humid day. If the mountain were warmer than the cloud mass there would be no condensation, but some of the moisture of the cloud would be evaporated and float away in the prevailing winds.

An unusual amount of moisture in the air in summer produces a feeling of closeness; physical labor is more enervating than when the air is dry and crisp. The change from sultry, oppressive weather is nearly always brought about by a series of thunderstorms, sometimes lasting over two days.

Summarizing the indications that may be drawn from the temperature and moisture of the air, it would appear that an increase in the amount of moisture in the air is a sign of a change from fair to foul weather, both winter and summer. In the colder months an increase in the temperature of the air above the average for the season, coupled with an increase in moisture, is a sign of rain or snow within twenty-four to forty-eight hours. In the summer an increase of temperature alone is not always an indication of rain. But these are not infallible rules. The old proverb "All signs fail in dry weather" is as true to-day as when first formulated.

### THE WIND AND ITS SUCCESSIVE CHANGES.

The wind is less prophetic in character than the clouds, since it is affected by the form of the land over which it blows. Thus, it has a tendency to blow up a valley in the daytime and in the contrary direction at night, no matter in what direction the valley may extend. Winds also have a tendency to blow toward and up the sides of a mountain slope in the daytime and down the side of a mountain at night, and this movement of the air generally extends for some distance out from the foot of the mountain on the level slopes. There are also the well-known land and sea breezes of all countries where, during the twenty-four hours of the day, the temperature of the land becomes alternately warmer and colder than that of the sea. These winds (valley, mountain, land, and sea breezes) are called diurnal winds. They are caused by differences in temperature that are not general, but confined to the valley or mountain slope of a particular locality. In order that these differences of temperature may arise there must be clear weather and unobstructed sunshine. It is easily seen then that all such winds must be most active in fair weather, and that when they cease, or fail to appear at the usual time, the atmosphere as a whole must have come under an influence greater than that which produced the diurnal winds.

In the open country or other exposed situation where the true direction of the wind can be determined, it should be noticed first, what is the prevailing direction of the wind in fair weather, and what is the direction from which storms usually come. The direction of the wind during the twenty-four hours immediately preceding the storm should be especially noticed. To do this a short journal or diary of the weather should be kept. The direction of approach of storms in the United States varies in different localities. It is quite important that each observer determine for his immediate neighborhood the shift of the wind with the approach of storms, during the colder months at least.

In the warm months the winds are light and rather variable, and changes in direction have not the same importance as in the colder months. The rain of summer generally occurs in connection with thunderstorms; it will be found that these are most frequent for a certain direction and with the wind in a particular quarter. Beyond the fact that more thunderstorms come from a westerly quarter than from any other direction, little can be said that will be of value in forecasting their approach by the direction of the surface winds only. The coming of a thunderstorm can generally be foretold a few hours in advance by the form and movement of the clouds.

In the colder months, viz, November, December, January, February, March, and April, the winds are stronger than at other seasons of the year, and storms also move with greater rapidity. The signs of falling weather in the colder months are the formation of a high sheet cloud covering the whole sky, an increase in the temperature and moisture of the air, and the change of the wind to some easterly quarter. The precise direction that the wind takes, whether northeast, east, or southeast, varies for different localities and the direction from which the storm is approaching. In New England, the Middle States, and the Ohio Valley northeasterly winds precede storms that approach from the southwest, and southeasterly winds precede storms that approach by way of the Lake region. On the Pacific coast southeasterly and southerly winds precede rain storms.

In Wyoming and other Northwestern States the heavy snowstorms of winter and spring generally come from the north or northwest with a strong wind from the same direction. The direction of the wind depends very much on the position of traveling storms that pass across the country.

The storms of the cold season have certain well-marked characteristics that should be easily recognized by every worker in the open air. These are: (1) The changes in the aspect of the sky; (2) the direction of the wind before, during, and after the storm; and, (3) the shift of the wind, whether with or against the sun.

The clouds that precede the storm by from twenty-four to thirty-six hours are almost invariably light, wispy cirrus, of the general character shown in Pl. IX, fig. 1. Soon after the appearance of clouds of this class a sheet cloud forms at a slightly lower elevation and gradually thickens until the sun is hidden. Pl. IX, fig. 2, illustrates the sheet cloud in the first stages of formation.

The subsequent clouds are much darker than those above mentioned, and appear to form at much lower elevations. When the sky becomes overcast the wind generally freshens, the temperature rises, and the air becomes humid; in popular speech, "it feels like rain."

### LOW PRESSURE AND HIGH PRESSURE.

The weather experienced from day to day depends upon the frequency and the course followed by areas of low pressure, and the succeeding areas of high pressure which generally follow them. These are exceedingly variable both as to direction and rate of movement. Some move rapidly from the Northeastern Rocky Mountain slope to the maritime provinces of Canada at a uniform rate, while others have a rapid rate of progression at the beginning, but quickly slow down and finally cease to move. There are, however, certain characteristics possessed by both highs and lows, which, if once fully understood, would greatly assist the individual observer in making a forecast of the weather for the morrow. The diagram (fig. 8) is a reduced copy of the daily weather map of December 15, 1892, and is introduced to illustrate some of the characteristics above mentioned.

If we divide the diagram into four equal parts by lines passing east and west and north and south through the word *low*, and calculate the average temperature for each part or quadrant of the oval figure, we will find it to be 17° for the northwestern quadrant, 50° for the southwestern, 59° for the southeastern, and 35° for the northeastern. The distribution of temperature is also shown by the dotted lines (isotherms). In the upper left-hand corner of the diagram the temperature is 10° below zero (−10); between that line and the one next below, temperature varies from 10° below to zero, and so on until the lower left-hand corner is reached, where it will be noticed temperature is 60° above zero. On the lower right-hand corner temperature is only 40° above zero. So far as temperature is concerned, therefore, we note that the right-hand[1] side of an area of low pressure is warm and the left cold.

The direction of the wind is shown by the small arrows in different parts of the diagram. These, it will be noticed, are disposed about the center of the storm (the inmost oval marked "Low") in a rather orderly system. The wind does not blow directly toward the center, but rather spirally about it, as discovered a little more than half a century ago. In the southeast quadrant the winds have a general southerly direction, in the northeast quadrant easterly winds prevail, while in

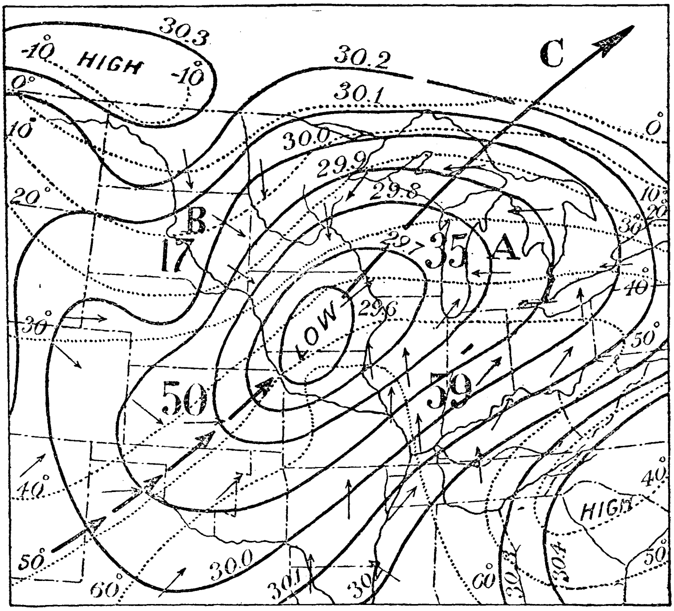



FIG. 8.—Weather map (reduced) of December 15, 1892, showing typical winter storm.

the northwest and southwest quadrants the winds are mostly northwest to west. An observer stationed in lower Michigan at the point *A* will have fresh easterly winds, shifting as the storm center approaches him around to the south by way of southeast, and as the center passes him shifting still farther to the west or northwest. This is what is meant by "shifting with the sun." On the other hand, an observer in South Dakota at the point *B* first experiences a wind from the north, and as the storm center approaches and passes him the wind backs to the west by way of northwest, and this is the meaning of the term "shifting against the sun, or backing." The weather experienced in the two locations, *A* and *B*, will differ as regards both temperature

[1] A person standing in the center of a storm, facing in the direction in which the storm is moving, will have the warm side on his right hand and the cold side on his left and in the rear.

and precipitation. At station *A* the temperature will rise, and it will continue high until after the center of the storm has moved, say to *C*. With the shift of the wind to the northwest the temperature will begin to fall and the downward tendency will continue for twelve to twenty-four hours. The observer at station *B* will experience cold weather from the start, but the fall in temperature will not be quite so great as at station *A*. At station *A* the storm will begin with a warm rain, turning to sleet and snow as the center passes and the wind shifts to a westerly quarter. At *B* the precipitation will be mostly in the form of snow.

## CONCLUSION.

The foregoing few generalizations apply equally well in all parts of the country east of the Rocky Mountains. They will be found most useful, however, in the middle and upper Mississippi and Ohio valleys, the Lake region, and the Middle States. As soon as they are thoroughly understood the local observer will be able to detect in the atmospheric changes, apparent to the eye or apprehended by the sense of feeling, the coming of an area of cloud and precipitation with its attendant whirling winds—warm on the front and right-hand side and cold in the rear and on the left-hand side.

# AGRICULTURAL EDUCATION IN FRANCE.

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## INTRODUCTION.

France has a remarkably complete system of agricultural education. It is more comprehensive than our own, in that it reaches a wider range of people, and its different parts are more closely coordinated, the whole system being under the control of one central authority. It begins in the rural primary schools with the simplest facts of agriculture, extends through every phase of practice and theory in special schools, and culminates in a national institute, where the highest forms of agricultural instruction are given by a staff of the first men of science of France.

In this system there are schools for the sons of farm laborers who expect to continue in the vocation of their fathers; schools for the sons of the peasant proprietors and the small-farmer class who expect to return to the farm; schools for the sons of landed proprietors who will manage estates and act as leaders in agricultural progress; schools for training teachers of agriculture, managers of agricultural technical industries, and high officials for serving the state at home and abroad in agricultural positions. Not only do these schools give instruction in agriculture in general, but there is also extensive provision made for the conduct of special schools to meet the wants of different sections of the country. These include schools of dairying, viticulture, poultry raising, irrigation and drainage, cheese making, silk making, fish culture, forestry, horse breeding, technical agricultural industries, horticulture, veterinary science, etc. In this article it is proposed to outline the general provisions of the scheme observed in France for agricultural instruction and to describe some of the more important schools.

## NATIONAL DEPARTMENT OF AGRICULTURE.

At the head of the whole agricultural system in France is the National Department of Agriculture. The department was created in 1881 for the purpose of promoting the interests of agriculture. It is made up of four great technical divisions, namely, agriculture, breeding of horses, forestry, and agricultural hydraulics. The purpose of the department is to obtain and distribute agricultural information, to stimulate agricultural research and teaching, and to further the agricultural interests of France. To aid in this work an extensive series of publications has been instituted. These publications report the laws of the country relative to agriculture and the official acts of the ministry of agriculture, give the annual and decennial agricultural statistics of the country, and contain agricultural reports, memoirs of specialists, and papers on different phases of agriculture. Various reports of agricultural schools, departmental professors, and experiment stations are also published. Supplementary to these publications, the ministry encourages authors by buying and circulating agricultural books acknowledged to be useful to agriculturists. From $5,000 to $7,500 is expended each year in this way.

The issuing of publications, however, is only one of the means of encouraging agriculture. Far more effective than this is the extensive system of agricultural teaching adopted. Since 1898 the supervision of this teaching has been intrusted to a "Superior Council of Agricultural Education." This consists of 30 members, and is charged with the general supervision of all institutions affording agricultural instruction founded or subsidized by the ministry of agriculture. "All proposals for the formation of new schools are submitted to the council, and it receives the reports of the directors and professors. The council meets at least once a year and forwards a general report to the minister of agriculture, containing its views respecting improvements or alterations of the system as a whole. The minister of agriculture is the president of the council. * * * Members other than those holding their positions ex officio are appointed for four years, one-half of the number retiring every two years. Fifteen members of the council form a permanent association, which meets to consider urgent matters whenever summoned by the minister of agriculture."

For the more detailed work of inspection there are three inspectors-general. These organize the Paris and district agricultural shows and inspect the national schools of agriculture and the Agronomic Institute at Paris. In addition, there is one inspector for each of the eight agricultural districts of the country. These inspectors have the supervision of the lower agricultural schools and of the departmental and special professors. They also organize and preside over district shows.

With this brief survey of the general system of supervision, some of the more important institutions provided for agricultural teaching may be noticed.

### THE AGRONOMIC INSTITUTE.

This is the highest institution giving agricultural instruction in France. It is located in Paris, and was first opened to students in 1876. It is a post-graduate school of university type for all other agricultural institutions in France, except the School of Forestry at Nancy and the School of Horse Breeding at Le Pin. Its purpose is to qualify students for (1) agriculturists and proprietors of estates; (2)

professorships in the national and practical schools of agriculture and for departmental and normal-school professors; (3) administrators, capable of taking charge of special agricultural investigations, as inspection, phylloxera investigations, etc.; (4) directors of agricultural experiment stations; (5) chemists or directors of agricultural industries (sugar making, distilling, starch making, manufacture of fertilizers), or agricultural engineers (mechanical, drainage, irrigation, etc.).

The institute has at its disposal suitable laboratories and buildings, and in addition about 65 acres of land, which is used for the growing of plants and research work of the professors, for the object of the school is not only the teaching of all the known facts of the sciences relating to agriculture, but also experimentation in new fields. The teaching staff, consisting in 1899 of a personnel of sixty-five, contains among its members many of the highest scientific authorities of France. Such familiar names as Boussingault, Hervé-Mangon, Schlœsing, Aimé Girard, A. Carnot, Risler, Delesse, Breuil, Tassy, Prillieux, Müntz, etc., are found on the first faculty roll of the institution, some of whom are still occupying chairs in the school.

Candidates for admission to the school must be at least 17 years old, and are subject to competitive examination in the natural sciences, French composition, and descriptive geometry. For graduates of universities or the national schools of agriculture and veterinary science, the examinations are somewhat modified. Under certain conditions students may be admitted to the lectures without examination, but are debarred from laboratory work, and are not granted a diploma. Tuition is about $100 per year for regular students, and $10 for students attending the lectures only. The school has no dormitories.

Work begins at 8 o'clock a. m. and continues until 4 p. m., with an intermission of one and one-half hours at noon for lunch. All exercises and studies are compulsory. There are six scholarships having an annual value of about $200 each, and four of a value of $100 each, offered by the state. Free tuition goes with these scholarships. There are ten other scholarships giving free tuition alone, and in addition certain other scholarships offered by the city of Paris and Seine department to native-born students.

The course of study occupies two years, with a vacation of three months each year. Two months of each vacation are required to be spent in actual agricultural practice, either in France or abroad, and a report of the work must be handed in. Excursions to fairs, stock markets, etc., are a prominent feature of the course. The subjects each year of the course are as follows:

FIRST YEAR.—Vegetable physiology and anatomy, descriptive botany, mineralogy and geology, mathematics, agricultural mechanics, physics and meteorology, general chemistry, general agriculture, viticulture, general zootechny, political economy, rural hygiene, agricultural zoology, and the anatomy and physiology of animals.

SECOND YEAR.—Vegetable pathology, microorganisms, agricultural chemistry, special and colonial crops, comparative agriculture, arboriculture and horticulture, agricultural machinery, agricultural hydraulics, special zootechny, agricultural technology, farm law, rural economy, economic forestry, and agricultural bookkeeping.

Upon the completion of the course the degree of agricultural engineer is granted. The first 60 who have attained a standing of at least 70 per cent for the whole two years are exempted in time of peace from two of the three years' compulsory military service. The two students standing highest on the examination list are eligible for three years' special missions either in France or in foreign countries, with a Government allowance of $579 per annum. The first 10 or 12 on the list, depending on the needs of the state for foresters, are eligible to studentships in the National School of Forestry at Nancy, and are given an allowance of $300 per year. The three highest among those desiring work in the Government horse-breeding school are made eligible for such positions. Nine others, selected on the basis of scholarship, are eligible to positions equivalent to one-year fellowships either in the laboratories of the institute or elsewhere in agricultural industrial occupations, with an allowance of $20 per month. Former students at the institute who possess the bachelor's degree in addition to the diploma of the institute are eligible for attachéships, consular, and other administration positions.

A recent report shows that of 882 graduates of this school, 91 per cent are engaged in agricultural occupations or industries immediately related thereto.

## NATIONAL SCHOOLS OF AGRICULTURE.

There are nine national schools of agriculture in France—three of general agriculture, three of veterinary science, and one each of horticulture, dairying, and technical agricultural industries.

### NATIONAL AGRICULTURAL SCHOOLS.

The most noted of these schools is located at Grignon, near Paris. This school was founded as a private institution in 1826, and is the oldest agricultural institution in France. It was placed partly under Government control and patronage in 1849, and in 1872 was reorganized, together with the agricultural school at Rennes in western France and the school at Montpellier in the extreme south of France, into a national school of agriculture, under the direct control of the state, and supported entirely by it.

The three national schools of agriculture are more practical in nature than the National Agronomic Institute, and correspond more nearly to the State agricultural colleges in this country. Their purpose is to fit young men for positions as managers of estates and as teachers of agriculture. The teaching in these schools is both theoretical and practical. The course covers two and one-half years at Grignon and Montpellier and two years at Rennes. Only day students are received at Rennes. At Grignon and Montpellier students may obtain full board, or half board, or they may board away from the school. Tuition with full board costs $232 per year at Grignon and $193 at each of the other two schools. With half board, tuition is $116 per year. Day students pay $80 per year. Students hearing the lectures and taking practical work, but who do not take laboratory work, pay $40 per year. They receive neither diploma nor certificate. Military discipline is observed at the schools, and is very strict. Deviation from the rules without previous permission or failure at the sessional examinations entails expulsion. Candidates for admission to the full course in these schools must be at least 16 years old, and are subject to both a written and an oral competitive examination in French, elementary mathematics, physics, chemistry, and natural science. Those who pass the written examinations are permitted to take the oral examination. The number of vacancies in the school is fixed annually by the minister of agriculture, and seldom exceeds forty. Men only are admitted. Students standing highest on the examination list have first choice as to the school which they will enter.

Upon the completion of the course the diploma of the school is conferred by the minister of agriculture. It carries with it two years' exemption from military duty, and counts a certain number of points on the entrance examination at the National Agronomic Institute.

The teaching in the different schools is made to conform largely to the agricultural requirements of the districts in which they are located. Thus, at Grignon general agriculture, as the growing of cereals, roots, and forage crops, the breeding of stock, pasturage, and the general agriculture of northern France are dealt with especially. At Montpellier the farming is more subtropical, and the cultivation of the orange, olive, mulberry, and the vine, and the processes of wine making are studied especially, as well as methods of irrigation and the replanting of moorlands and mountain sides. The school has given special attention also to parasitic diseases, the combating of the phylloxera, and in renewing the destroyed vineyards of the district. The school at Rennes is located in an important cider-producing and pasturage district, and hence much attention is given to these subjects.

The courses of study in the different schools are very similar, only slight differences appearing in the more practical part of the work. The course at Grignon may be selected for illustration: It consists of agriculture, botany, general and agricultural chemistry, economics, rural legislation, rural engineering, construction and repair of agricultural machinery, physics, meteorology, agricultural technology, sylviculture, viticulture, and pomology. Lectures are also delivered by specialists in geology, mineralogy, horticulture, and entomology. The students also receive instruction in military tactics.

Connected with each school is a farm for practical work, an extensive library, and well-equipped laboratories. The farm at Grignon contains 321 acres of arable land and 370 acres of woodland, besides various kitchen, botanical, and other gardens, especially adapted to the study of certain branches. Specimens of the best breeds of sheep, cattle, pigs, and poultry are kept, and experiments made with different crops and fertilizers. Attached to the institute as annexes are several establishments for making researches and experiments. These are the poultry farm at Joinville le Pont, in the neighborhood of Paris; an experiment station for determining the best kind of seeds to be sown, when to sow them, and when to harvest; another for experimenting with different kinds of agricultural machinery; a laboratory for the special study of fermentation as applied to brewing, and to wine, cheese, and butter making; and a laboratory of vegetable pathology, where plant diseases are studied. The machines are taken apart and reassembled by the students, and their uses and modes of repair explained by expert machinists.

At Montpellier a school for the breeding and study of silkworms has been organized for the better instruction of the students and a meteorological department added for the same purpose.

These national schools train the major portion of the leaders in French agriculture. They supply most of the departmental and special professors of agriculture, the teachers of the lower agricultural schools, and the managers of estates and technical agricultural industries. The many receive higher agricultural instruction in these schools, while but comparatively few are able to take post-graduate work at the National Agronomic Institute.

### NATIONAL HORTICULTURAL SCHOOL.

The National School of Horticulture at Versailles was established in 1873. The old kitchen garden of Louis XIV was placed at the disposal of the school for practical work and demonstrations. The place consists of about 25 acres of fruit and vegetable gardens, greenhouses, forcing houses, etc. The institution has a three years' course in theoretical teaching and practical horticultural operations. Tuition is free. Pupils board themselves. The age of admission is between 16 and 26. Students must be physically capable of performing manual labor, and are subject to a competitive written and oral examination. The number admitted each year is limited to forty. There were seventy-seven applications for admittance to this school in 1900. The student body is made up largely of the sons of the laboring and middle classes. Some eighteen scholarships in this school are offered by the state and by various departments and agricultural societies to the students who receive the highest entrance examination marks. Scholarships are about sufficient to cover the board and lodging of the holders. The teaching force of the school consists of twelve professors and four chief gardeners and overseers. The course includes instruction in orchard and small-fruit culture and the growing of vegetables, flowers, and ornamental shrubs in the open and under glass, nursery methods, greenhouse architecture, elementary and descriptive botany, bookkeeping, drawing, the English and French languages, leveling as related to horticulture, elements of mathematics, physics, meteorology, chemistry, geology and mineralogy, pomology, zoology, and horticultural entomology.

Theoretical teaching in these subjects is supplemented by practical work in the vegetable garden, forcing house, botanical garden, orangery, grape and peach houses, nursery, rosary, flower garden, and on the lawns, walks, and terraces of the grounds. Laboratory work in physics, chemistry, and botany is also given.

The school hours are from 6 a. m. to 9 p. m. in winter, and from 5 a. m. to 9 p. m. in summer, with intervals of one and one-half hours for meals. Four hours in winter and two and one-half hours in summer are given to theoretical teaching. At the end of each two weeks pupils make a report to the director on their work. In addition to the work of the school, excursions are made to a number of the more important horticultural establishments for the purpose of observation.

A general examination is held at the end of each year. Those who have completed the work receive a diploma from the minister of agriculture. In 1894, 89 per cent of the graduates of the school were engaged in horticultural operations. There is a wide demand for their services throughout France, and the school is believed to meet a specific want in French horticulture.

### NATIONAL DAIRY SCHOOL.

The National Dairy-Farm School was established in 1888. It teaches the theory and practice of butter and cheese production, is a station of information for the district on all subjects pertaining to the dairy industry, and conducts experimental investigations along dairy lines. It is intended to meet the wants of young men who expect to take up dairying as an occupation, and of all others who wish to acquaint themselves with the latest and most improved dairy practices.

The school is well equipped with all the latest machinery and apparatus necessary for the production of first-quality products. The milk used is obtained by a cooperative arrangement with neighboring farmers. A field of about 7 acres is attached to the school. Here soiling crops are grown intensively. The botanical garden contains plants which are known to affect the quality of milk. The course lasts one year, and is gratuitous. It includes dairy farming, chemistry, technology, zootechnics, bookkeeping for dairy farms, the elements of general physics and chemistry, mechanics, microorganisms, and botany. Practical work is had in the manufacture of butter and the varieties of cheese best suited to the French market.

The teaching staff consists of a director, professor of technology and chemistry, veterinary surgeon, professor of zootechnics, two experts in cheese manufacture, and a milk inspector. Candidates for admission to the school must be between 17 and 30 years old. Those holding the diploma of a primary school, farm school, or of a practical agricultural school are admitted without entrance examination. Others are examined in mathematics and the history and geography of France and her colonies. Pupils room and board themselves. There are a number of scholarships for deserving students, which are obtained by competitive examination.

The school is especially valuable to the district in which it is located. It gives practical advice on all matters pertaining to dairy interests and conducts experimental work in feeding milch cows, to determine the effects on the quantity and quality of the milk of certain rations and methods of feeding.

### NATIONAL SCHOOL OF AGRICULTURAL INDUSTRIES.

The National School of Agricultural Industries at Douai was founded in 1893, for the purpose of giving professional instruction to young men who purpose to become foremen or managers of sugar factories, distilleries, breweries, or other technical agricultural industries. The school is restricted entirely to French students. All students are nonresidents. The full course covers two years. Tuition is about $96 per year. There are a few scholarships for deserving pupils. Candidates for admission must be at least 16 years old. Special courses are offered to pupils wishing to study a particular branch. Graduates of the National Agronomic Institute or of the national schools of agriculture are required to spend only one year at the institution.

The staff of the school consists of a director, subdirector, eight professors, four tutors, and one mechanic. The general course includes elementary and applied mathematics, mechanics, industrial drawing and construction, physics, chemistry, agricultural zootechny, rural and industrial law, and bookkeeping. The technical course includes instruction in the manufacture of sugar, distilling, brewing, and divers other technical industries, as the manufacture of starch, vinegar, etc.

Theoretical instruction is supplemented by practical work. For this purpose, according to a recent report of the Victorian Royal Commission on technical education, "the school is provided with all the appliances essential for the manufacture of sugar, the distilling of alcohol, and the brewing of beer. The producing capacity of the machinery amounts to 220 gallons of alcohol and 260 gallons of beer per day, and the sugar can be extracted from about 20 tons of beet roots daily. Diplomas and certificates are awarded at the end of the course to students who succeed in obtaining the standard marks, and this document can be specialized for any particular industry or industries."

### PRACTICAL SCHOOLS.

These schools are intermediate between the national schools just noted and the farm schools to be described later. They are intended for the sons of the peasant proprietor and small farmer classes. It is expected that those who attend them will return again to the farm, not finished agriculturists, yet well grounded in the fundamental principles of agriculture. Many of the students in the national schools are graduates from these practical schools.

The practical schools are not wholly national, but are usually in part departmental, local, or private schools. The Government pays for the teaching and usually for a few scholarships, approves the course of study, and has general oversight of the schools, but all the buildings, equipment, and the farms connected therewith must be supplied locally. Usually the schools are held on domains and in buildings remodeled for the purpose. The farms attached vary in size from 100 to 350 acres.

The course in the different schools varies from two to three years, with a tendency to reduce the number to two years. It is about equally divided between theoretical instruction and practical work in the stables and on the farm. The practical work is diversified in the different schools to correspond to the general needs of the district in which it is located. The theoretical teaching, however, is fairly uniform in all, as follows: Arithmetic, geometry, surveying, leveling, linear drawing, agricultural geography, physics, meteorology, agricultural chemistry, zoology, entomology, botany, plant diseases, general agriculture, special cultures, farm machinery, farm law, animal husbandry, sanitation, horticulture, tree culture, farm accounts, morals, French, and military exercises.

The school staff generally consists of a director, who may also be a professor; one professor each of agriculture, physics and chemistry, and natural sciences; a veterinarian; a supervising principal; a superintendent of agricultural work; a superintendent of horticulture; and a military director. The professors in the schools are usually graduates of the National Agronomic Institute or of the national schools. The cost to the state for teaching in these schools varies from $3,500 to $4,800 per annum for each school.

Candidates for admission to these practical schools are subject to an examination in French, arithmetic, and the history and geography of France, unless they hold a certificate of elementary education. The age of admission ranges from 14 to 16 years, and the average number of pupils in each school is from thirty to forty. Tuition, board, and lodging at the schools vary, according to locality, from $77 to $116 per year. Tuition alone is $10. Pupils usually board at the schools.

At the present time there are forty-three of these schools in different parts of France. Twenty-four are agricultural schools, two schools of irrigation and drainage, five schools of southern and Algerian cultures, four schools of viticulture, seven dairy and cheese schools, and one school of aviculture.

These schools have proven especially valuable in improving the agricultural operations of the peasant farmers of France. The knowledge of their worth has extended far outside of the boundaries of France, and they have been imitated in nearly all of the countries of Europe.

## FARM SCHOOLS.

The French farm schools are practical schools of apprenticeship. They are designed primarily for the purpose of training the sons of the peasant laboring class in the practical details of farm work. The use of farm machinery and tools, care and management of animals, the seeding, cultivation, and harvesting of crops, and other farm work are taught practically. Theoretical instruction is given in the French language in arithmetic, surveying, leveling, farm bookkeeping, and the more general principles of agriculture, horticulture, and arboriculture.

These schools were first established by private initiative, and up to 1845 nine had come into existence. At this time the Government became interested in them, and a law was passed organizing them all on a uniform basis. State aid was given for defraying the expenses of the teaching personnel and for boarding the apprentices, but leaving to the director or proprietor of the estate on which the school was located the care and responsibility of the direction of the school and the expenses and profits of running it. The state requires the farm on which the school is conducted to be a model for the surrounding neighborhood. Each year a programme of work must be submitted for the approval of the administration. The schools are inspected by the district inspectors of agriculture and are reported upon by them to the minister of agriculture regarding their control.

The teaching force of these schools, besides the director, generally consists of a superintendent, who teaches the apprentices the use of tools and farm machinery and directs the field operations and the indoor work of the barn and stables; a bookkeeper, who teaches farm accounts and takes such elementary classes as may be necessary; a gardener, to direct the operations of the vegetable garden and orchard; and a veterinarian, to give instruction on the hygiene and characteristics of animals and discuss the more simple operations of first aid to be given them in time of need. This force is sometimes supplemented by specialists, as a chief irrigator, viticulturist, dairyman, etc.

The period of apprenticeship at these schools varies from two to three years. Pupils are admitted when 16 years old, and the average number in a school is about twenty. Those who do not hold a certificate from the primary schools are examined in the elementary branches and must pass a physical examination. Upon the satisfactory completion of the course, a diploma is given and a bonus of $60. Those who do not obtain a diploma receive a bonus of $39.

Supplementary to the farm schools are a number of other schools of a like grade. These include two sheep-farm schools, one silk school, fourteen cheese-making schools, one school of fish culture, and two primary agricultural schools.

At one period these farm schools were very popular in France. Up to 1850 some seventy had been established. From that time on the number gradually decreased until the present time, when there remain but fourteen. Many of the original schools have been converted into the practical schools of agriculture, previously noted. Others declined because the peasantry were unwilling to part with the aid of their children for two or three years when they might learn about the same thing and at the same time earn from $50 to $75 per year on a well-managed estate. At the present time most of the farm schools are in the south of France, where agriculture is least advanced, and the work at most of them closely approximates the work offered in the practical schools.

## AGRICULTURE IN THE PUBLIC SCHOOLS.

The schools thus far described are given up entirely to agricultural teaching. There remains for discussion the public-school system, in which agriculture is but one branch of the general course. Agricultural instruction is given in all French normal schools for men, and by the laws of 1879, 1887, and 1888, it has been made obligatory to teach in the rural elementary schools the elements of the natural and physical sciences, with their application to agriculture. According to the French programme of 1887, which is translated in full in the Report of the U. S. Commissioner of Education for 1895–96, agricultural instruction in the primary schools is as follows:

ELEMENTARY PRIMARY INSTRUCTION.—*Elementary course (pupils 7 to 9 years old):* First lessons in the garden and school. *Middle course (pupils 9 to 11 years old):* Ideas appropriate to what the child has read; object lessons and excursions for the purpose of familiarizing pupils with soils, fertilizers, tillage, and common implements. *Higher* *course (pupils 11 to 13 years old):* More methodical instruction on tillage, implements, drainage, fertilizers of all kinds, sowing, harvesting, domestic animals, and bookkeeping; ideas about horticultural propagation, tree culture, and grafting.

SUPERIOR PRIMARY INSTRUCTION.—*Advanced course for boys and girls over 13 years old:* Practical ideas about vegetation, the duration of growth, and reproduction (by seeds, buds, grafts); different kinds of lands, manures and their use, and rotation; the use of agricultural implements and machines; principal operations in agriculture, such as breaking up land, planting, transplanting, drainage, and irrigation; principal crops of France and of the locality; diseases of plants, parasites; legumes, fruits, flowers; use of sash; training and pruning fruit trees; care of domestic animals; bee culture.

About 3,400 of the rural primary schools have gardens attached to them. There are 160 superior primary schools, in which more than 15,000 pupils receive instruction in agriculture.

Official circulars have been issued by the ministry of agriculture suggesting the ideas and purposes involved in the agricultural instruction to be given. These direct that the instruction shall be addressed less to the memory than to the intelligence of the child. It should be based on the observations of facts in country life and on simple experiments with familiar objects, and designed to prove the scientific fundamental ideas of the most important agricultural operations. The children should learn above all things else the reasons for the operations rather than the manner of performing them. Still less should they be compelled to learn a list of definitions, precepts, or agricultural recipes.

The aim of the elementary instruction is to give the greatest number of country children that degree of elementary knowledge which is essential to enable them to read a modern book on agriculture or attend an agricultural meeting with profit; to inspire them with a love of country life, so that they may prefer it to that of towns and factories; and to inculcate the truth that agriculture, besides being the most independent of all occupations, is also more remunerative than many others for industrious, intelligent, and well-instructed farmers.

It was difficult in the beginning—and the difficulty has lasted well up to the present time—to initiate the teachers into the spirit of the new teaching in the primary schools. Books on agriculture were placed in the hands of the pupils; agricultural rules, even though sometimes debatable, were taught as axiomatic truths; the memory rather than the understanding was consulted, and the learning of words rather than the observation of facts was made the basis of agricultural teaching.

In order to supply teachers with an adequate knowledge of the principles of agriculture, a course of agriculture was established in all the normal schools for men. It was not intended that the normal schools should be turned into agronomic institutes, but that agriculture should be given an honorable place in the school curriculum. It was desired to give the graduates of such schools an exact knowledge of the soil, the means of improving it, the methods of cultivation, and the general management of farms, gardens, and stables. According to the minister of education, it is sufficient if teachers in the elementary schools teach simply the elements of agriculture, give wise counsel in the neighborhood, and, if necessary, combat effectually routine and prejudice. To accomplish this the instruction given by the teacher should be accurate and clear. The ideas of the pupils should be rectified by visits to the best farms, by some laboratory work, and by frequent tests in the garden or demonstration field of the school. The object of the course in the normal schools is not to teach the business of farming, but to study the phenomena of life and the condition of its development, to inspire a love for the country, and to develop the natural tendencies of children to become interested in flowers, birds, etc.

In the normal-school programme for teachers two hours a week are devoted to agriculture, zootechny, and rural economy in the second year of the course, as follows: (1) *Vegetable growing*—study of the soil; the means of modifying its chemical composition and physical properties by fertilizers; irrigation; drainage; cultivation; rotation of crops, and special crops, such as cereals, legumes, etc. (2) *Zootechny*—feeding of horses, cows, sheep, and swine. (3) *Rural economy*—property in land; methods of exploitation and capital required; bookkeeping. In the third year of the normal course one hour a week is devoted to fruit-tree and vegetable growing, as follows: General ideas of culture; planting and preparing the soil; work in the orchard and garden. It is expected that the professors will emphasize the methods and products of the localities in which the schools are located.

### DEPARTMENTAL AND SPECIAL PROFESSORS.

Thus far there have been described simply the schools in which the youth of France receive instruction in agriculture—the National Agronomic Institute, the national schools, the practical schools, the farm schools, the rural primary schools, and the public normal schools for men. There still remain the farmers themselves, who need instruction, and besides the whole system of agricultural instruction needs to be bound together and unified. For the purpose of general supervision there are, as already mentioned, the three inspectors-general and the eight district inspectors. There are also the departmental and special professors. A department in France may be compared in a general way to a county in the United States. In 1894 ninety of the departments of France had been supplied with departmental professors of agriculture, as authorized by the law of 1879. There were also 114 special professors. The respective functions of these two officers are as follows:

The departmental professor is charged (1) with giving a two years' course in agriculture in the public normal schools (see page 127), thus grounding the future teachers in the rural primary schools in the principles of agriculture, and (2) with holding at least twenty-six institutes a year. The object of these institutes is to teach the farmers of the district facts regarding seeds and varieties, the use of commercial fertilizers, treatment of vines, replanting vineyards, and the means of combating drought, excessive moisture, insect ravages, etc. He lectures always on subjects of most interest to the local agriculturist, and is under the direct control of the department of agriculture, though paid in part by the department of education.

The special professor gives (1) a course of agriculture to the pupils in the last two years of the superior primary schools, and (2) short courses to adults in some of the rural wards. The course for adults given by the special professor differs from that given by the departmental professor in that "the province of the first is to inform; that of the second to teach." The special professor gives short courses of from four to ten days' duration, according to the needs in different localities. It is intended that this work shall supplement the information acquired in the superior primary schools and in schools of practical agriculture, to refresh the memory of older students of agricultural schools, bringing up to date the latest agricultural information, and to prepare the farmers to follow with profit the instruction of the departmental professor.

These annual reviews of agricultural progress are believed to be of much practical benefit to rural interests. The lack of experience sometimes found in young professors is commented on unfavorably, but on the whole the agricultural teaching of the departmental and special professors is in good favor. During the year 1893 more than 300,000 farmers and teachers were in attendance at the departmental institutes.

The departmental professor has still another rôle in agricultural teaching. Not only does the French Government require that farmers be taught the theory of agriculture by word of mouth, but they must also be taught the fact by ocular demonstration. For this purpose small fields of demonstration have been created, where the good effects of fertilizers or tillage operations, varieties, etc., may witness to the locality the truth of the theories presented in the institutes and conferences. These fields of demonstration are under the direct control of the departmental professors. They are popular with the people, and are ranked among the most powerful factors for increasing French agricultural productions. In 1894, 3,362 of these fields of demonstration had been created in the different departments of France.

### EXPERIMENT STATIONS AND LABORATORIES.

In addition to the fields of demonstration already noted, there were in 1894 seventy-seven establishments in France for agricultural analysis and research. These also render much service to the agricultural population. In the laboratories fertilizers, food stuffs, soils, seeds, waters, etc., are analyzed, and in the stations original investigations in agricultural problems are undertaken. These experiment stations are usually smaller institutions than our own, and in comparison are relatively weak in working force, equipment, and resources. They are, however, of very great use to the localities in which they are located.

### SUMMARY.

To sum up, the various factors which enter into the agricultural educational system of France are:

(1) The rural primary schools, in which are taught the elements of the natural and physical sciences as related to agriculture. The aim in these schools is to create in the pupils a love of nature and to give them a knowledge of the simplest facts in agriculture. They reach the masses. As a preliminary, there is involved the systematic training of teachers in the departmental normal schools for this work.

(2) The maintaining in each department and nearly every commune of trained agriculturists, who conduct successive short courses in agriculture especially adapted to the needs of the community at the time, manage fields of demonstration in the locality, thus manifesting to the eye the truth of the theories presented and the value of scientific methods in agriculture, and act as a bureau of agricultural information for the community at all times. They teach the farmers themselves. The experiment stations and laboratories, widely distributed throughout France, serve much the same purpose as these trained agriculturists, and undertake some original investigations pertinent to the locality.

(3) The semiprivate farm and practical schools for the training of sons of farm laborers, peasant proprietors, and the small-farmer class in the best farm practices, and grounding them in the basic principles of scientific agriculture. They train the men who are to do the actual work on the farm.

(4) The national schools, giving a higher grade of instruction in agriculture, horticulture, forestry, veterinary science, and the technical agricultural industries to sons of the large landed proprietors and to the more apt pupils of the lower schools. They train the teachers and leaders in agricultural progress and furnish managers of agricultural industries.

(5) The National Agronomic Institute at Paris, serving as a kind of

post-graduate school in agriculture of a university type, and commanding the services of a corps of the ablest scientific men in France. Here the latest facts in scientific agriculture in France and elsewhere are accumulated and published, and original research work in agriculture is undertaken. It trains teachers and leaders capable of raising and maintaining the agriculture of the country on a high level, of serving in governmental positions, or of molding the agricultural policy of the state.

Summarizing, then, for the whole country, it will be seen that, besides obligatory teaching in all rural primary schools, France has, in all, 12 institutions for teaching agriculture of the first and second degrees, 43 for teaching the third degree, 34 for pure practice of apprenticeship, 3,362 fields of demonstration, 77 establishments for analysis and agricultural research, and 214 departmental and special professors of agriculture, who give instruction yearly to 300,000 adult farmers and conduct agricultural classes in the normal schools for men and in the rural primary schools.

# COMMERCIAL PLANT INTRODUCTION.

By Jared G. Smith,
*Chief of Section of Seed and Plant Introduction.*

## INFLUENCE OF INTRODUCED PLANTS ON AGRICULTURAL DEVELOPMENT.

At all times the introduction of new plants into a region has been an essential part of the development of its agricultural resources. Of the more than one hundred thousand species of flowering plants, only a few hundred have been brought into cultivation, and a score of these supply the daily food requirements of two-thirds of the human race. With the exception of the pumpkin and a few grapes and small fruits, a few forage plants, grasses, and native drug plants, every crop required for the manifold needs of a diversified farming industry and grown on a commercial scale in the United States has been introduced from foreign countries. These introductions have taken place gradually, as the necessity or the opportunity arose. Corn, wheat, cotton, tobacco, oranges, apples, many grapes, flax, hemp, sugar cane, rice, hops, barley, beans, cabbage, oats—all these originated in foreign lands. The native plants of this country, excepting only the grasses and forest trees, have played an unimportant rôle in the agricultural development of the land.

## COOPERATION WITH EXPERIMENT STATIONS IN PLANT INTRODUCTION.

The work of systematic plant introduction must necessarily be undertaken in its initial stages in cooperation with the State experiment stations. If an attempt is made to distribute new and untried seeds and plants direct to the farmer without thorough investigation of all phases of the growth of the plant, the work necessarily becomes so diffuse that it is impossible to control it or secure adequate results. The experiment-station workers are better acquainted with local conditions than private experimenters, and hence can be more effective in controlling a new disease or checking the spread of destructive insects. Their judgment is often better as to what constitutes merit in a new crop. They can exercise that selection which is so often necessary, developing a plant through the years in which it is being adjusted to the new conditions and environment until its type has become fixed. Many crops, such as fruits, nuts, drug plants, forest and timber trees, and grasses and forage plants, require long and careful experimentation to confirm the judgment of the introducers in regard to their excellence. No crop should be attempted on a commercial scale until it has received such careful trial. Furthermore, no crop should receive the wide advertising that necessarily accompanies indiscriminate distribution unless it has been tested on the grounds of an experiment station. Even then distribution should be limited to those localities in which the crop is known to succeed. The office of the Department is to direct lines of plant introduction, and to check, as far as need be, that unbalanced optimism which often follows hasty experimentation. It is a common characteristic of the human race to want something for nothing. The ideal forage plant would be one producing 10 tons of hay per acre, with 10 inches of annual rainfall, without cultivation or the use of fertilizers. Thousands of dollars are thrown away yearly by American farmers, planters, orchardists, and stock raisers in an attempt to reach the unattainable—to secure crops which will place their growers in a position of affluence without effort, care, or attention.

In many lines of agriculture American farmers are far in advance of those of any other country. Further advance must come from further specialization, in farming just as in commercial enterprises. It is here that the Department of Agriculture can help the farmer. A century ago wheat was wheat and an apple was an apple. To-day there have been developed varieties of apples and strains of wheat to suit localities where in the old days neither could have been grown. There are more than a thousand varieties of each, bred up to satisfy conditions, uses, and tastes which a century ago did not exist. A transfer of many of the localized plant industries of Europe, Asia, and the Orient to suitable situations in our own land, and their establishment on a firm basis, is a logical field for systematic plant introduction. A study can be made of the soils, climate, methods of cultivation, harvesting, and marketing of the special product; similar regions can be picked out through the agency of the experts in the Department and in the experiment stations, and the new industry transplanted to the place where it is most likely to succeed. A successful importation of this character will well repay much purely experimental work, both because of the added wealth to the United States as a whole and because of the resultant diversification of American farming. Every new industry established on a substantial and paying basis may mean incidentally diminished imports of that product, but the more important result is that it gives employment to people and increases the potential wealth of the country. Seeds and plants from foreign countries are not necessarily valuable just because they are foreign. The value of such introductions lies in a proper understanding of the local conditions under which the plants are grown or marketed. These conditions can not be thoroughly learned from books or by correspondence. They must be investigated personally in all their phases and every cause predetermined that will lead to a successful result.

There are many agricultural products in foreign countries which would fill no niche in the necessities of the people of this country. The American farmer prefers good dairy butter to the sunflower oil of the Russian peasant and meat rather than the bean curds of the Chinese. But the cultivation of the sunflower may be undertaken, using our improved methods and machinery, as feed for poultry or in combination in feeding rations; also the soy bean for forage and hay to fatten animals. New varieties of sunflower may be obtained from Russia or new soy beans from Japan to satisfy our needs in these particulars, while the cultivation of specialized crops, such as the Austrian pickle cucumber, Bohemian horse-radish and hops, Smyrna fig, French truffle, and Algerian date, may be attempted on a commercial scale with a direct application of all the methods of cultivation used in each of those countries.

### COMMENCEMENT OF SYSTEMATIC PLANT INTRODUCTION.

Seed and plant introduction was first undertaken by the Department of Agriculture on a systematic scale in 1897. Previous to that time there had been many introductions, some of which were successful, adding much to the value of the agricultural products of this country. Among these were Turkey wheat from Russia, the Washington navel orange from Brazil, and sorghum and Kafir corn from Africa and China. There are now about 600,000 acres planted to Kafir corn in the State of Kansas alone, and it has been predicted that within ten years at least 2,000,000 acres will be grown annually in that State. It is probable that any one of these introductions has more than paid the cost of the whole work of the Department of Agriculture since its inception.

### PURPOSES OF THE PLANT-INTRODUCTION WORK.

The work of plant introduction naturally and logically falls along a number of parellel lines, each of which may be of great importance.

#### INTRODUCTION OF NEW CROPS.

One of the purposes of plant importation is the introduction of new crops, in order that there may be grown within the borders of this country all of that wide range of plant products now purchased abroad. The agricultural imports of the United States amounted during the last fiscal year to about $420,000,000, approximately one-half as much as the agricultural exports during the same period, and equaling about 12 per cent of the value of the total farm products of the United States. About two-thirds of the value of agricultural imports consisted of plant products.

The range of temperatures, soils, and climatic conditions is probably as great in the United States as in any other region of similar area in the world. Our farm products vary widely from cotton, oranges, tea, and sugar cane, in the extreme South, to barley, oats, and potatoes, in the North. With the new dependencies, such as Porto Rico, Hawaii, and the Philippines, the climatic range is greatly increased, and it might be safely affirmed that almost every one of the products now imported from foreign countries will some day be grown in the United States. The figures of imports[1] of breadstuffs, including corn, oats, rye, wheat, and other cereals, average nearly $3,000,000 per year; for foreign vegetable fibers, including cotton, we spend annually about $23,000,000; for fruits and nuts, $18,000,000; for indigo, $2,000,000; for rice, over $3,000,000; for spices, nearly $3,000,000; for sugar, $89,000,000; for tea, $12,000,000; for tobacco, $7,000,000 to $17,000,000; for such vegetables as beans, peas, cabbages, onions, potatoes, and cucumbers, $2,000,000. We also buy drugs, dyestuffs, condiments, hops, vegetable oils, opium, plants, trees, shrubs, vines, ginger, cocoa, seeds, starch, vanilla beans, tanning materials, gums, and many other articles. The establishment of any one of these as a new industry on a commercial basis would be well worth all of the time and all of the money expended by the Department in the effort.

There are two ways in which the objects to be accomplished may be attained: One is the devoting of all the time and all the money available along a few lines of investigation; the other, the sending of explorers into each of the foreign countries from which we buy any considerable proportion of our imports to procure samples of everything which that country produces, in the hope that some of these products will, in the course of time, upon trial, prove adaptable to our conditions. In one case all of the energies of the explorers would be devoted to the study of a few crops, such as hops, brewing barleys, raisin grapes, drugs, date palms, rice, or wheat. In the other, an explorer thoroughly cognizant of the needs and conditions of a given region in the United States would be sent to some foreign country where the climatic conditions were similar, in order to introduce into that region all or as many of the new crops as would in his judgment be desirable. If all the energies of a force are devoted to the investigation of a few chosen problems, the results can be more nearly predicated, and it is probable that more can be accomplished by the expenditure of a given sum in a given period than by the method of general exploration. In either case, the utmost care must be maintained to prevent the introduction into the United States of bad weeds, serious plant diseases, or destructive insect pests. Extreme vigilance is required. It is often a difficult matter for an explorer to obtain the best, especially when dealing with producers in a country that is a commercial rival of the United

[1] The statistics of importation here quoted are from a forthcoming report of the Section of Foreign Markets (Bulletin No. 23, Our Foreign Trade in Agricultural Products, 1891–1900).

States. The actual cost of exploration in foreign countries must in all cases be considered in connection with the results to be achieved. Agricultural exploration in its most important sense must be considered a special line of investigation in order to secure quick and satisfactory results.

INTRODUCTION OF IMPROVED STRAINS OF CROPS.

Besides securing new crops for new regions, an extremely valuable line of work, and that which appears most profitable, is the introduction of improved strains of crops which have long been cultivated in a given region. The area devoted to wheat amounts to about 44,000,000 acres in the United States and the average yield per acre is only 13 bushels. If, by the introduction of new varieties of wheat from other wheat-growing regions, the average could be raised to the extent of only 1 bushel per acre it would mean an increased production of 44,000,000 bushels yearly. No one will deny that such an improvement is possible. Varieties have already been obtained, especially in the line of soft white wheats, hard winter wheats, and hard spring wheats, that yield as much as 10 bushels above the average. The Millers' Association of Kansas and Oklahoma has taken steps to import for distribution among the wheat growers of the States named 20,000 bushels of a variety of a red winter wheat, originally imported by this Department from the Crimea, in Russia. This wheat is not only superior in yield to varieties previously grown in that region, but is more hardy to winter cold and shows greater resistance to rust.

Another commercial importation of this character—that is, the improvement of a crop already well established—is that of the Kiushu rice, which was secured through the Section of Seed and Plant Introduction by Dr. S. A. Knapp in Japan. This rice has now been grown three seasons in southwestern Louisiana and southeastern Texas. The best experts say that it does not deteriorate under cultivation. Honduras rice, the variety previously grown, deteriorates within three years, so that it is hardly worth sowing. The percentage of head rice quickly decreases, because the grains become more starchy and break in milling. The Japan rice, on the contrary, has a short and very hard grain, which breaks very little in the milling process, so that a greater quantity of head rice (rice with unbroken grains) is produced. Not only is there more head rice, but the yield per acre averages fully 25 per cent more than that of Honduras rice. One lot grown at Crowley, La., gave the following milling record in November, 1900: Eight hundred and seventy-one sacks, weighing 161,000 pounds, yielded 94,500 pounds of head rice, 9,400 pounds of screenings, and 3,500 pounds of brewer's rice, and the whole crop gave a profit of $3.85 per barrel of 162 pounds. It was practically all head rice. The Department's importation of Kiushu rice has reduced the amount of broken grains, or brewer's rice, produced by the mills in southwestern Louisiana until it is impossible to get enough to fill orders. All this helps the rice farmer, because the head rice is worth about $5.25 per hundredweight, while brewer's rice averages only about $1.75.

The introduction of an improved strain of any crop previously cultivated thus becomes a measure of great commercial importance. The United States produced in 1899 over 73,000,000 bushels of barley, valued at nearly $30,000,000, and the exports during the year ended June 30, 1900, amounted to 23,700,000 bushels. There are three general classes, the six-rowed and four-rowed barleys, used for feeding purposes, and the two-rowed or Chevalier barleys, used for brewing. The American feeding barleys are as good as any, but this much can not be said of the brewing barleys. The best German, Bavarian, and Moravian sell for prices 20 to 30 per cent above those of the best American barleys. Barley for feeding purposes is rich in nitrogen, with the grains hard and flinty in cross section. Brewing barleys, on the contrary, contain a much smaller percentage of nitrogen, and are softer and more starchy in cross section. They are also brighter in color and have thinner hulls, and there is a very considerable difference in their favor in the amount of wort which can be obtained from them during the malting process. The best Bavarian barleys were worth on November 1, 1900, in the local Bavarian markets, from 95 cents to $1.05 per bushel. On the same day the quotation for the best American barley on the New York market was 60 to 65 cents per bushel. Adding the cost of ocean freights, which amount to from 17 to 22 cents per bushel from New York to the German and Austrian markets, there still remains a considerable difference in price in favor of the foreign grain, and this difference in value is solely due to the superior quality of the grain. Very little Bavarian or German barley is imported into the United States, but the imports of Bavarian and German beers manufactured from the superior German and Bavarian barleys amount to about $1,000,000 annually.

In each case where an importation is made the seeds or plants should be placed either where the experiment will be under the supervision and direction of the Department of Agriculture or of the workers in the various State experiment stations. A trial should be made of all seeds and plants imported in order to determine beforehand, in a measure, their adaptability to American conditions. If this is not done, it may result in much loss to individual farmers or planters, but as soon as the fact is definitely established that a new crop or new strain has merit, a wider distribution is justifiable, provided the distribution is accompanied by full information in regard to all of the conditions governing the growth of the plant. Following the successful establishment of a new crop or a new agricultural industry, the sale of the seeds or plants will inevitably be taken up by seedsmen, nurserymen, and horticulturists, and when this stage is reached the Department of Agriculture can safely leave to them the further exploitation of the crop. On the contrary, the Department of Agriculture can better stand the expense not only of foreign exploration but of the years of experimentation which so often yield no commercial results.

### INTRODUCTION OF NEW VARIETIES FOR PLANT BREEDERS.

Another line of investigation in which systematic plant introduction can be very helpful to American plant growers is that of introducing new varieties for the professional plant breeder and plant selector, but this work takes a longer time than the introduction of improved varieties, and for this reason must long remain of only secondary importance. Nevertheless, the Department can be of great assistance to many experiment-station workers and private investigators by procuring from all over the world seeds and plants for use in such investigations.

### SUCCESSFUL PLANT IMPORTATIONS.

Almost every new crop which is brought in and every improved strain of plant must necessarily become changed in the process of cultivation under new conditions and in new environments. Selection of the best in cultivation in the United States must be coordinate with selection of the best things from foreign countries. New strains from foreign countries are often extremely important because of the superior vitality of the plants themselves and the strong individual characteristics shown in their resistance to disease, alkaline or acid soils, drought, and winter cold, or in their ability to mature a crop with the minimum supply of water. The Jannovitch Egyptian cotton is an excellent example of this, because of its superior resistance to the wilt disease, which has proved so disastrous to the sea island cotton growers in the South. Turkestan alfalfa, which was procured in central Asia, has proved to be more resistant to drought, to winter cold, and to alkali than the common strain, and it also grows and makes a crop with less water.

### TRIALS OF VARIETIES BY STATE EXPERIMENT STATIONS.

There have been many successful importations during the past four years, as reported by the State experiment stations. Considering the fact that much time must often elapse before satisfactory progress can be made, there are many gratifying indications of the value of systematic plant introduction.

Alabama station.—The Russian field pea has proved to be one of the most promising new forage plants at the Alabama station. It has proved eminently valuable as a forage plant and soil cover and for green manure. This and the hairy vetch fill an important need in the South.

ARIZONA STATION.—The director of the Arizona experiment station states that the importation of dates from Algeria is an extremely valuable one for the development of a new industry in the southern portion of the Territory. Enough trials had been made previously to know that the date palm would grow and produce fruit abundantly in the Salt River Valley. Fully 90 per cent of the trees which were brought in have commenced to grow. The economic cacti from Argentina and from the Mediterranean region have found in Arizona a region which apparently supplies every condition necessary for their growth and development. The fruit and forage value of these can not of course be fully known for some years to come, but the fact of their having taken kindly to the region is a good indication of their usefulness in the future. A frost-resistant lime is growing finely. The kei apple from South Africa has grown eight months out of doors, and although retarded somewhat by extremely hot weather, promises in the course of time to make a fine green hedge. The Khiva winter muskmelon has done excellently on the experiment station grounds at Phoenix and also in the hands of a number of ranchers to whom it was sent.

CALIFORNIA STATION.—An achievement of overshadowing importance in California has been the final establishment of the Smyrna fig industry by the successful introduction of the fig-fertilizing insect.[1] Prof. E. J. Wickson considers that the industry which the fruit growers will be quick to establish will soon be yielding a product worth a million dollars annually. The introduction of the best white wheats from Australia, Japan, China, and Europe is one of the best results which has recently been accomplished for California agriculture. California has long stood in need of new varieties of this class to replace the old which are running out, and it is believed that this one effort will return more value to California than the whole work of seed and plant introduction has cost since its establishment. The securing of date trees true to name is another notable accomplishment which will be slower in reaching results because of the nature of the plant and its limited multiplication, but it is the writer's opinion that the next generation will count this one of the greatest agencies for the development of the warmer portions of the arid Southwest.

At the Amador substation, Prof. C. H. Shinn reports that March rape, from France, was sown in November, 1899, on both slate and granitic soils, and on the granitic-slate wash at the foot of the hills. It grew from 3 to 3½ feet high, blossomed from April 15 to 30, and

[1] The details of the establishment of the Smyrna fig culture in this country are given in a separate article in this Yearbook.—ED.

ripened seed by June 1. It yielded 32 tons per acre of green forage without fertilizer or irrigation. A plat sown on a slate soil long used as a garden and rather rich, but not irrigated, yielded at the rate of 47 tons per acre and grew 4½ feet high. This rape suits the Sierra foothills much better than dwarf Essex rape, and is worthy of more general cultivation in that region. Goat's rue from France, sown on a slate soil in March, made a strong growth, and was cut for fodder in July, when it was 24 inches high. It made a second growth of 20 inches by August 30 without fertilizer, but with some irrigation. Unirrigated plats made one cutting and kept green all summer. The Narbonne vetch yielded 12½ tons of green forage per acre and the hairy vetch 16 tons. The common, scarlet, purple, and hedge vetches also made a very fine growth, indicating that they are worthy of more extensive planting in the Sierra foothills. These vetches did even better in northern California. The European lupines and many forms of field peas have also done well, as have the soy beans, cotton, sorghums, and the Russian millets.

At the Pomona substation the large Victoria field pea from Russia has proved a very desirable acquisition as a green manuring plant for winter use in the orchards of that portion of California. The series of vegetable marrows from Italy made a remarkably vigorous growth on damp, semialkali soils. They are considered superior to the summer squash now on the market, bearing equally well and being of much better quality. Three varieties of soy beans from Japan made an excellent combination, supplying a succession, the earliest variety being entirely out of the way before the last was near maturity.

At the Tulare substation a white broom-corn millet from Tashkend, Russian Turkestan, was more resistant to drought and alkali than wheat. It made good hay and would be profitable for either hay or chicken feed. Professor Shinn considers this an acquisition to California, better than the "Golden" or any other of the older varieties of millet grown in that State. An improved variety of wild furze, having a somewhat irregular pyramidal shape and with less rigid spines than the wild form, has proved a remarkable plant in its resistance to alkali and drought. It may, under further trials, be developed into a good range forage plant in the drier portions of California.

Colorado station.—At the Colorado experiment station some of the varieties of wheats introduced by this Department have been of great value. Prof. L. G. Carpenter states that the finding of one variety better than those in common use will amply justify any expenditure undertaken. At the Plains substation four varieties of Russian muskmelons have proved to be of exceptional value—the Kochanka, Apricot, Lida, and Tiflis-Erivan No. 2. These are in addition to the Khiva, which has proved to be so marked a success in Colorado, Utah, and other Rocky Mountain States.

GEORGIA STATION.—At the Georgia experiment station the Egyptian clovers are reported as being very promising, having made a rapid, vigorous, and robust growth. These clovers, if successfully introduced, will prove extremely valuable for winter soil cover and green manure crops in the Southern States.

IOWA STATION.—At the Iowa experiment station a variety of oats from the province of Perm, in Russia, yielded at the rate of 72 bushels per acre, while five other foreign varieties yielded 50 bushels per acre. A variety of emmer, from Russia, yielded 40 bushels per acre, and four varieties of imported barleys from Russia yielded from 57 to 68 bushels.

KANSAS STATION.—At the Kansas experiment station the winter Ivanof rye from Russia did extremely well. The chick pea, or garbanzos, from France made a very fine growth, and seemed to be quite promising compared with other legumes tried. Three varieties of soy beans from Japan did finely, and one of them, a late variety, produces pods without any rank or bitter taste, indicating that it might be developed into a good garden vegetable. Prof. H. M. Cottrell says:

> Some of the most valuable work done for the State of Kansas was the introduction of the Kafir corn by the Department of Agriculture a number of years ago. In western Kansas it is a sure crop nine years out of ten, while corn can not be depended upon more than one out of every three. As soon as the farmers learn how to feed Kafir corn western Kansas will be as great a cattle-feeding section as eastern Kansas and Iowa are to-day. The introduction of Kafir corn has been of sufficient value to Kansas to pay for the cost of all importations of seed made by the Department of Agriculture. A second introduction that promises to be of great value is *Bromus inermis*. From present tests we look forward to its taking a valuable place in Kansas agriculture.

KENTUCKY STATION.—At the Kentucky experiment station three varieties of soy beans from Japan did well, and the early maturing ones seemed especially adapted to cultivation in Kentucky. The hairy vetch has proved extremely well suited to the locality and soil and promises to be of great value as a forage plant.

MICHIGAN STATION.—The director of the Michigan experiment station reports that the sand lucerne *Medicago media* is destined to be a great soil renovator on sandy soils in that State. "It is one of the best hay plants now in use on the experiment station farm, yielding this year (1900) 5 tons of cured hay to the acre on a sandy knoll. I regard the value of this one importation as sufficient to warrant the Government in maintaining the Section of Seed and Plant Introduction if no other services had been performed."

MISSOURI STATION.—At the Missouri experiment station Prof. J. C. Whitten reports that the everlasting radish from Japan proved to be one of the sweetest and best radishes ever grown. Its particular merit is that as a garden radish it does not become strong and woody, but remains crisp and tender during the entire summer. This radish has also attracted attention because of its possibilities as an autumnal forage crop. As the cool weather of autumn approaches it begins to develop a thick leafy growth at its crown, just at the surface of the ground, the plant apparently utilizing the food stored in the large root for this purpose. Cattle and sheep eat the leaves and crown growth with relish, and, as it makes this growth at a time when other green feed is not abundant, it will probably be a valuable new forage plant as well as a good vegetable. The silver-ribbed chard from Italy is more tender than any other variety ever grown at this station. It is brittle, delicately colored a fine creamy white, with thick, fleshy, tender stems. The vegetable marrow, "Charles Naudin," from Italy, is of merit because it produces a succession of fruit from early summer until frost, and is enormously productive. The vines continue to grow in length throughout the summer, and as they lengthen a succession of fruit is produced, so that when frost comes there are tender fruits near the new growth of the vine and fully ripe ones near the base. The vines grow to be 30 feet in length and bear 15 to 20 fruits. It is used like the summer squash, and is superior in flavor to the best.

NEBRASKA STATION.—At the Nebraska experiment station, Prof. T. L. Lyon states that there have been two importations of very notable importance. The first is Hungarian brome grass, the value of which can hardly be estimated at the present time, but which is undoubtedly very great. The second is Turkestan alfalfa, which promises to extend very considerably the area of alfalfa cultivation on the uplands in western Nebraska. Prof. F. W. Taylor, formerly of the Nebraska experiment station, secured in 1896 a variety of Russian oats, the "Local Cherson," admirably adapted to the prairie soils and climate. It has been grown three years at the Nebraska station, where it matures earlier and yields better in ordinary seasons than any other variety tried.

NEW HAMPSHIRE STATION.—At the New Hampshire experiment station the Lida muskmelon from Russia has been very promising. This melon is of medium size, round to oval, strongly ribbed, with deep salmon-red, juicy, and delicately flavored flesh. The skin is thin, flesh thick, the seed cavity small, and it matures in New Hampshire. It is a valuable muskmelon for northern localities.

NEW YORK STATION.—At the New York State station a Russian cabbage, not in itself especially well-bred, indicates a possibility of supplying a very valuable type, as it is a strong grower and exhibits great hardiness under extreme climatic conditions, but it will take several generations of careful selection to develop its full capabilities.

NORTH CAROLINA STATION.—At the North Carolina experiment station the very early Violet de Barbentane eggplant proved to be resistant to bacterial blight, which entirely destroyed the American sorts of eggplants in adjoining rows. Prof. W. F. Massey states that it is the earliest eggplant he has ever grown. It is very productive, exempt from blight, and is little attacked by insects. Its earliness, its resistance to drought and intense heat, and its wonderful productiveness mark this as being an extremely important importation, although as a market sort it may not compare with old established varieties, because of its shape and color. It is shaped like a ripe cucumber, and is light purple. In flavor it is far superior to the old varieties.

NORTH DAKOTA STATION.—At the North Dakota experiment station two macaroni wheats have yielded far above the ordinary varieties, and have produced large enough crops to warrant the establishment of the macaroni manufacturing industry in that State, thus putting on foot a new line of business enterprise as well as adding a new crop for the farmers. A Russian variety of oats and one of barley rank second among the whole list of varieties tried. A Russian spelt outyielded any variety previously grown by 5 bushels per acre, and a Russian buckwheat yielded 10 bushels more than the best local sort. The latter solves the problem of successful buckwheat cultivation in this region. Two of the imported Russian broom-corn millets gave enormous yields of seed, indicating that they will be profitable to grow for stock feed. Prof. J. H. Shepard says: "I have no hesitancy in saying that the Department of Agriculture has given this State many thousand dollars' worth of value in the importations which I have mentioned."

OREGON STATION.—At the Oregon experiment station Turkestan alfalfa gives promise of being perhaps the most valuable of introductions. It is found to be well adapted to rather dry soils or semiarid districts where irrigation is impracticable. It is hardier and grows with less moisture than the common varieties. The broom-corn millets from Russia are also valuable. They mature quickly and produce an enormous amount of seed. Two crops can be grown in one season. There are also two varieties of Russian wheats, which give much promise because of their yield and their superior drought-resistant qualities.

RHODE ISLAND AND MISSOURI STATIONS.—At both the Rhode Island and Missouri experiment stations *Perilla arguta*, an ornamental plant from Japan, made a very handsome growth. Its foliage is very attractive, the mixture of purples and greens in the color of the leaves being quite unique, making it very attractive for massing in beds where plants of this character are desired.

SOUTH DAKOTA STATION.—At the South Dakota experiment station the Tambof and Voronezh millets and the Zhelanni oats from Russia have proved valuable. Prof. J. H. Shepard says:

The station is using every endeavor to propagate and distribute seeds of these three varieties among the farmers of South Dakota. The Turkestan alfalfa has proved hardy, and will materially extend the area of alfalfa production in South Dakota. A macaroni wheat from Russia, the Pererodka, has grown so well that it indicates that macaroni factories can be established in South Dakota. The Malakoff sugar corn is from ten days to two weeks earlier than the earliest variety, and is quite drought resistant. Though the ears are short, being only from 3 to 6 inches long, every stalk bears from two to four ears, and it is the sweetest corn ever tried at this station.

TENNESSEE STATION.—Prof. A. M. Soule, of the Tennessee experiment station, says "some of the seeds sent us, when compared with other varieties, were highly successful—in several instances heading the list." Among these are Sandomir winter wheat from Poland and Yaroslaf winter wheat from Russia. The Shatilof and Swedish Select oats from Russia are very promising, and an early soy bean from Japan was the best of seven varieties, yielding 6 tons of forage per acre.

TEXAS STATION.—At the Texas experiment station the green gram from western China promises to be a superior forage plant. This bean has great drought-resisting qualities, makes a large quantity of foliage, and a very heavy crop of beans.

VERMONT STATION.—Several varieties of legumes, including the edible podded sugar peas and lablab, or Madagascar bean, were tested at Middlebury, Vt., under the direction of the Office of Experiment Stations. Dr. C. F. Langworthy states that a dwarf variety of the pea had pods large enough for use in about six weeks from planting. A great advantage of these peas is that the pods are best for table use when the seeds are only partially grown, perhaps a week before they are large enough for shelling. When the pods are old enough to be rather tough, the peas are in fine condition for shelling. Those tested were of superior flavor, and fully equal to the best varieties of shelling peas. "It seems unfortunate that the edible podded pea should not be better known, as it is of very pleasing flavor, and apparently of easy cultivation." The edible podded lablab beans planted May 1 made a very large growth of vines. The blossoms are white, nearly as large as sweet peas, and of a very pleasing appearance. A crop of beans was obtained about the first week in October. They were greenish-white in color, and tender when cooked. The success of this bean in Vermont was probably due to the phenomenally long autumn. In ordinary seasons it would not be likely to succeed so far north.

WASHINGTON STATION.—Prof. W. J. Spillman, of the Washington experiment station, states that the Hungarian wheats have yielded very largely compared with other varieties, and, although they have not as yet been grown in quantities large enough to judge of their milling qualities, it is his belief that they will become valuable in the great wheat-growing section of the Northwest. All the varieties of the chick pea, or garbanzos, seem to be eminently adapted to the soil and climate of eastern Washington, and the indications are very strong that this will become a very valuable legume for this section of the country. The smooth brome grass is growing rapidly in popularity among the farmers of Washington, and is now fairly well established as a standard grass in this State.

WISCONSIN STATION.—At the Wisconsin experiment station the Swedish Select, Tobolsk, and Zhelannii oats from Russia have shown themselves to be particularly adapted to northern latitudes. The Russian emmer and the Black Voronezh broom-corn millets appear to be very promising varieties.

### JANNOVITCH EGYPTIAN COTTON.

The Jannovitch Egyptian cotton was grown in South Carolina under the direction of the Division of Vegetable Physiology and Pathology. In common with other Egyptian varieties it shows a marked resistance to root disease. It has many good qualities, chief among which are the length and quality of the staple and the vigor of the plants. When planted beside upland cotton, and compared with the latter, it has disappointed the planters by its small bolls, which make the cotton hard to pick, and also by its small yield. When compared with sea island cotton, however, it was found much easier to pick. The bolls appear whiter than the sea island. It does not seem to be adapted to all portions of the cotton belt, being too much inclined to run to weed on the rich, moist soils; nor does it grow large enough in the poor soils in the northern or hilly counties. The best success may be expected with this cotton in those parts of Georgia, Florida, and Alabama where the sea island cotton is more or less established, not only because these soils will probably prove to be best adapted to Jannovitch cotton, but also because the planters are accustomed to the cultivation and handling of long-staple cotton, and are already provided with the necessary roller gins. The Jannovitch will undoubtedly be of great value for use in producing new varieties of long-staple upland cotton by hybridization with our native sorts, and it may also prove very useful in efforts to produce a variety resistant to the root disease.

# FOREST EXTENSION IN THE MIDDLE WEST.

By WILLIAM L. HALL,

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## INTRODUCTION.

There is no question but that a certain amount of forest planting on the prairies is profitable to the owner and helpful to the country. To what definite extent such planting can be carried with profit has not been and can not be demonstrated except by trial. Those who have studied the question most thoroughly and over the greatest area are convinced that extensive planting will be profitable, but their specific recommendations, both as to extent of planting and methods of procedure, have been local in scope and application. No system for general operations has been proposed.

It is the purpose of this article to go somewhat beyond local recommendations, and to show that the time has arrived for the extensive development of forest plantations throughout the Middle West, to indicate the sphere of general planting, and suggest a plan of procedure in carrying out the work.

Profit is the only basis upon which this system can be carried into effect, and the only inducement for attempting it. Before a man can be induced to plant trees with the aim of reaping a forest crop he must be convinced that such a crop, for the time it occupies the land, will be more profitable than any other. The growing of timber is an investment on much longer time than the growing of any ordinary crop. Money is invested which can not begin to give returns for several years. No one will begin such an investment unless he feels that, in the end, it will be more profitable than any series of short-time investments he could make.

## PAST PLANTING.

Two facts are clear concerning Western plantations: First, there is a general aimlessness and lack of system in both planting and management; second, there is but a small percentage of thrifty plantations. In nine cases out of ten, planters have taken little thought to make their trees serve any definite purpose of utility. In localities where post timbers are scarce and dear, yards and fence rows have been filled with trees of no practical value; where winds are terrific and almost constant, plantations have been established toward the quarter from which no winds blow; trees that thrive best close together are planted far apart; those that thrive in porous soils are unhappily placed on clay. It all shows that there is not yet an adequate conception of the value of forest trees and the purposes they can be made to serve. Some plantations, established with no thought of returns, have grown into considerable value on account of the posts, poles, and fuel they have produced; but these are exceptions.

A limited number of plantations have been established and developed for profit. Most of these are Catalpa plantations in Kansas and Nebraska. Locust (Black Locust), Black Walnut, and Ash have been much planted in these and adjoining States. Some Red Juniper (Red Cedar) has been planted in Nebraska and Iowa.

The majority of these plantations fall short of their maximum returns from lack of congenial soil or proper management, but some of them are striking exceptions to the general rule, revealing skill and wisdom in their conception, and giving promise of rich returns. A 10-year-old block in the Catalpa plantation of L. W. Yaggy, near Hutchinson, Kans., showed a net value of $197.55 per acre.[1] A 25-year-old plantation of Red Juniper of F. C. F. Schultz, near Menlo, Iowa, showed a net value of $200.54 per acre. Many other plantations showing the same values could be named. These equal or exceed the returns given by agricultural crops for such a period of years.

The value of the above-mentioned plantations proves conclusively that timber can be grown for certain uses in a comparatively short time, and that it has a high value when grown.

Past planting shows that the growing of forest trees is a profitable enterprise, but it also shows that the work must be begun and carried out with judgment and skill if satisfactory returns are to be had. No mere probabilities of soil or trees can be accepted; no slipshod methods can prevail. The same careful management must prevail in tree growing as is required in any other business.

We have ample experience from past operations to understand fully the conditions necessary for success. For more than twenty years planting has been carried on, under great diversity of soil, moisture, and temperature, with all kinds of trees, and by every sort of method. The results present every degree of variation from absolute failure to perfect success. A careful study of these experiences reveals in every locality the methods requisite to the successful development of plantations.

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[1] The Division of Forestry has this year made extensive investigations in plantations of this character. The estimates here given are based upon actual measurements of the trees and present prices in the market.

### THE PRESENT TIME PROPITIOUS FOR FOREST PLANTING.

The diminution of natural timber in the Mississippi Valley has been general. On the eastern side the destruction of forests has been greatest because there the supply was greatest. The valley of the Wabash River is now cleared in most places to the banks of the stream. A prominent farmer of Vigo County, Ind., told the writer recently that he had but a half dozen remaining white oaks to use for posts, and that he would soon have to grow his own posts or buy them. That this sentiment is prevailing throughout Indiana, is shown by the fact that the Division of Forestry has been called upon this year to make plans for the planting of a number of tracts of timber of from 5 to 50 acres each in different parts of the State.

On the west side of the Mississippi a condition of greater scarcity prevails. Little timber is left in western Iowa and Missouri. The valleys of eastern Kansas, which produced large quantities of Black Walnut and Bur Oak, have largely been cleared. (Pl. XII, fig. 1.) Arkansas holds the greatest supply of valuable timber in the Middle West, but it is filled with sawmills, many of them of immense capacity, running day and night. The most valuable post and tie timbers of Arkansas are White Oak and Bur Oak, the supply of which is rapidly diminishing. There yet remains a remnant of Red Juniper in southwest Missouri and eastern Indian Territory, but it can scarcely last a dozen years longer, as the regions are now penetrated by railroads, and it is being shipped out as fast as it can be cut. Originally, the Red Juniper grew in considerable abundance in northwest Oklahoma along the Canadian and Cimarron rivers. A few years ago posts could be bought for 4 or 5 cents each. The supply is exhausted, and at the present time but a few posts can be obtained at even 12 or 15 cents each. The Red Juniper of the Platte Valley in Nebraska has gone in the same way. No natural supply from either of these regions need be reckoned on in the future. Osage Orange as a native timber is exhausted.

The consequence of this diminution of post, pole, and tie timber has been a general rise in prices. Good fence posts are now selling throughout the region at from 10 to 20 cents each. Ten years ago they could be bought at from 8 to 12 cents. Telegraph and telephone poles are worth 50 per cent more now than twenty years ago, and railroad cross-ties 25 per cent more. In the Great Plains, where there was no natural timber, prices have always been high and are now not much higher than ten or twenty years ago.

On extensive areas of the Great Plains and the Mississippi Valley, prices of posts, telegraph poles, and cross-ties much exceed the cost of growing them. This difference promises profit in timber growing. While prices are high enough for profits under present conditions, yet conditions are bound to improve. Every year finds the natural timber supply scarcer and prices higher. Mr. J. Hope Sutor, general manager of the Ohio and Little Kanawha Railroad, after giving the matter careful consideration, estimates the value of a cross-tie fifteen years hence at 75 cents. Mr. Sutor also says "no material has yet been found as a substitute for the wooden tie, and no satisfactory economical method of preserving the life of the wood or prolonging its durability has yet been discovered; and, excepting the minor questions of properly seasoning and piling, the use of the tie plate, suitable ballast and perfect drainage, and incidentally climatic conditions, no serious consideration of the future tie supply has yet been had."[1]

What is here said of cross-ties is true of all other timbers used in contact with the ground. While no metallic substitute has been found, their durability has not been greatly prolonged. The use of these materials must continue and will grow rather than diminish. Mr. Sutor's estimate of 75 cents for a cross-tie fifteen years in the future allows for an increase of about 50 per cent over present prices. This is a conservative estimate, and it is not unlikely that posts will increase as much and telegraph poles much more in that time.

From every reasonable point of view, it appears that great profits are to be made in the growing of forest trees in the next twenty-five years. Every condition is so favorable that the matter passes from probability to certainty. That operations should begin in the Middle West rather than in other regions is due to the fact that there the most favorable conditions exist; there the supply of natural products is most nearly exhausted, prices are highest, soil most fertile, and people most familiar with the processes of developing plantations. Operations will not progress far in that region before they begin in regions of the extreme East and West.

## SPHERE OF GENERAL PLANTING.

It is necessary in this connection to point out the purposes for which timber may be grown, the sections for successful operations, and the extent to which planting may safely be carried. While it is easy to go from fact to assumption on such a theme, yet the argument goes no further than to cover such simple operations as we may be positive about, in regions of which we have personal acquaintance.

### PURPOSES FOR WHICH TIMBER MAY BE GROWN.

FENCE POSTS.—The timbers best suited for this purpose are Osage Orange, Locust, Hardy Catalpa, Red Juniper, Mulberry, Black Walnut, Oak, and Ash.

Osage Orange posts have been obtained from native timber and from old hedge rows, mostly from the latter source. This tree has been used

[1] Address delivered at the July meeting of the Central Association of Railroad Officers at Louisville, Ky., and published in the Railway Age, July 27, 1900.

FIG. 1.—NATURAL BLACK WALNUT AMONG GREEN ASH AND HACKBERRY. VALLEY OF VERDIGRIS RIVER, WILSON COUNTY, KANS.

FIG. 2.—HARDY CATALPA, WIDE PLANTED, SHOWING RESULTS IN CROOKED, MUCH-BRANCHED TRUNKS. NEOSHO COUNTY, KANS.

Yearbook U. S. Dept. of Agriculture, 1900.

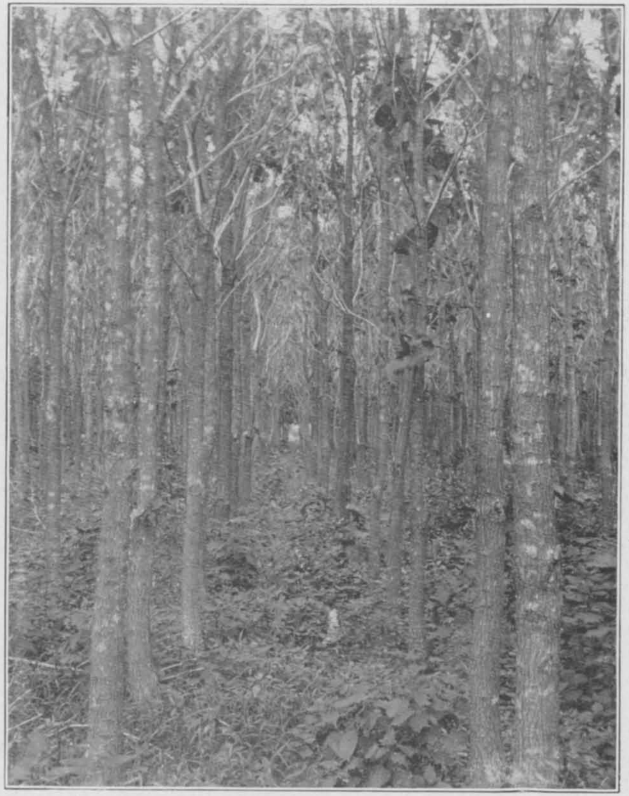

FIG. 1.—FOURTEEN-YEAR-OLD HARDY CATALPA, BEING GROWN FOR TELEGRAPH POLES. PLANTATION OF GEORGE M. MUNGER, GREENWOOD COUNTY, KANS.

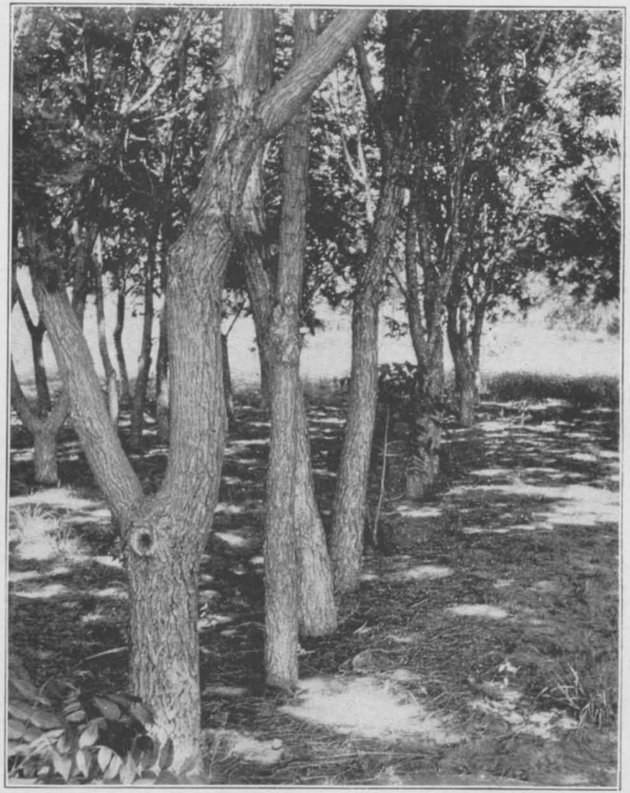

FIG. 2.—THIRTEEN-YEAR-OLD BLACK WALNUT, GROWN FOR POSTS. THE WIDE PLANTING HAS RESULTED IN LOW BRANCHING. COMANCHE COUNTY, KANS.

extensively as a hedge plant in eastern Kansas, Missouri, Iowa, and Illinois. Hedge rows sometimes turn out as many as 25 posts to the rod. It has seldom been planted except in this way, but will grow well in plantations. Its durability in contact with the soil is greater than that of any other wood commonly used, and it justly ranks high as a post timber. It requires from twelve to fifteen years to reach suitable size for posts.

Locust (Black Locust) is a well-known post timber. It grows rapidly, is well adapted to hard, stiff soils, and stands more drought than any other timber used for posts. These properties make it very popular in many parts of the West.

The Hardy Catalpa has been more abundantly planted as a post timber than any other tree. It is especially popular, and deservingly so, in eastern Kansas and Nebraska, where several large plantations have been made. It does best on deep, porous soils. Its durability in the ground has probably been overestimated by some but not fully appreciated by the public generally. When cut at the proper season its durability nearly equals that of the Osage Orange, but if young wood be cut when full of sap it is subject to attack by a fungus which destroys it rapidly. If to its durability we add its rapid growth, good form, lightness, strength, elasticity, immunity from checking or becoming unduly hard, we have an array of good qualities that to many men of experience place it first among post timbers. It requires from eight to twelve years to become large enough for use.

Red Juniper (Red Cedar) is a durable and valuable post timber, commanding good prices everywhere. Its main drawback is its slow growth, and it may never become popular as a domestic post timber except in limited areas. Twelve or fifteen years are required to grow it.

Mulberry, especially the Russian type, has made a good record in some sections of the West. It grows rapidly, is usually more or less crooked, but lasts well in the ground. It does best in porous, sandy soils, and when grown thickly in the row. It can be used in ten years after planting.

Black Walnut posts are used extensively in some localities. Posts from the old wood last a long time, but those from the young wood soon decay. It is of slower growth than Catalpa and Locust. (Pl. XIII, fig. 2.)

Oak, principally White Oak, Bur Oak, and Post Oak, has furnished more posts in the past than any other timber, the native trees being used. As the supply is exhausted in various sections its use will largely cease; it grows too slowly to be planted extensively.

Ash, principally White Ash and Green Ash, has been planted throughout northern Nebraska and South Dakota. Its growth is rather slow, from twelve to fifteen years being required to produce a post of good size. Its life in the ground is quite satisfactory, and for the region it seems to be the best post timber.

The use of posts is now enormous, and on the increase. Fences requiring them are the only kind now being established in this region. No rail fences are being built, and no hedges planted, except a few in Oklahoma. This being true, a very great demand for posts must ensue and continue from year to year. Since posts sell for higher prices in regions remote from natural timber, on account of added transportation costs, it follows that such regions are the best in which to have an available supply, and, if the conditions are favorable to the growth of timber, plantations will there prove most profitable. But in ten or fifteen years many regions which now have an abundant supply will show a scarcity, and prices will be high, so that in such localities it would be profitable to be planting timber even now.

TELEGRAPH, TELEPHONE, AND ELECTRIC POWER AND LIGHT POLES.—The timbers most used for these purposes are Tamarack, White Cedar, and Red Juniper. Their value is fully known, and if the supply could hold out nothing would displace them. Their life in the ground is about ten years, so that every decade sees one generation of poles worn out and another cut to replace it. To the poles required for renewal is to be added the number required for new lines and systems. The total is very large. The telegraph lines of the country require nearly 600,000 poles annually, at a cost of not less than a million dollars, and the telephone and electric car lines and light systems use as many more. The price of poles for such uses varies immensely, ranging from $1 to $50 each. If an advance in the price of post timbers is to be expected in the next fifteen years, a much greater advance may be expected in timbers of this class. A post may be grown comparatively quickly, and in an exigency almost anything can be used; but a telegraph pole must be long, straight, and of good quality. Timbers that fulfill these conditions are few, and a number of years are required to grow them. When the natural supply runs low, high prices will prevail. The man will be fortunate, then, who has a plantation of salable Red Juniper or Catalpa. Here again the Catalpa will show its excellence.

RAILROAD CROSS-TIES.—The timbers most in use for this purpose at the present time are White Oak, Post Oak, Bur Oak, White Cedar, Red Juniper, and Chestnut, with White Oak preferred. Prices range from 30 to 60 cents each for standard sizes; 620,000,000 cross-ties are in use in the railroads of the country and 90,000,000 are required annually for renewals, taking the timber from an estimated area of 200,000 acres. Railroad officials realize that tie timber is becoming scarce, and assert that prices are rising rapidly. Street car and suburban lines are now using many million feet of lumber for cross-ties.

It is certain that timber can be grown for railroad ties at a profit.

FIG. 1.—TWENTY-YEAR-OLD HARDY CATALPA APPROACHING SUITABLE SIZE FOR TELEGRAPH POLES. PLANTATION OF KANSAS CITY, FORT SCOTT AND MEMPHIS RAILROAD COMPANY. CRAWFORD COUNTY, KANS.

FIG. 2.—GROWTH OF PLANTED TREES IN THE ARKANSAS RIVER VALLEY. A SECTION WELL ADAPTED TO FOREST TREES.

Two extensive plantations of Catalpa at Farlington, Kans., established twenty years ago, have now some trees large enough for ties. The soil of the locality is not well suited to the Catalpa, and the management of the plantation has not been the best. Hardy Catalpa and Locust can be grown to the proper size for cross-ties in fifteen years under favorable conditions of soil and management. Only in certain localities of the West will the Oaks be planted for this purpose. The White Oak requires thirty or forty years to make the growth that the Hardy Catalpa makes in fifteen, whereas it is generally conceded that there is little difference in their value as tie timbers.

General lumber purposes.—When timber is large enough for cross-ties it is approaching readiness for other uses. There will always be great demand for this class of lumber for use in furniture, cars, implements, and vehicles. Whether it will be profitable to hold plantations for these uses rather than to sell them for the uses mentioned can not as yet be determined. (Pl. XIV.)

### SECTIONS OF SUCCESSFUL OPERATIONS.

Two features must characterize the sections of the country that permit of successful work in forest growing: First, the natural conditions must be congenial to the species used; second, the section must lie in or near a territory of good demand.

Species and sections adapted for profitable planting.—It is generally known that each of the species named above thrives best only in certain sections, and it has already been stated that the demand is greater and prices higher in some sections than in others. The attempt is made below to point out for each of the species mentioned the sections in which these two requirements are to be met. Some localities are omitted on account of minor area, others on account of lack of information concerning them, still others because one of the two requirements is not present, and only those which can be recommended with absolute assurance are mentioned for each species.

*Osage Orange.*—Valleys of the Red River, tributaries, and adjacent lowlands from western Arkansas to central Oklahoma; valleys of streams in eastern Indian Territory, eastern Kansas, and western Missouri.

*Locust* (*Black Locust*).—Oklahoma, Indian Territory, southern Kansas to Arkansas River, uplands of eastern Kansas and western Missouri; also hillsides of southern Indiana and Ohio.

*Hardy Catalpa.*—Valley of Arkansas River from west line of Arkansas to Garden City, Kans.; valleys of other streams in central and eastern Kansas and Nebraska to Platte River; southern Iowa in localities having porous subsoil; also southern Illinois and western Indiana. The Wabash River Valley is especially favorable.

*Red Juniper* (*Red Cedar*).—Valley of the Platte River, eastern Nebraska, eastern third of South Dakota, central, western, and northern Iowa, hillsides of southern Ohio, portions of southwest Missouri.

*Russian Mulberry.*—Sandy valleys of central Oklahoma, central Kansas, and southern part of central Nebraska.

*Black Walnut.*—Valleys with rich, deep, well-drained soil in eastern Kansas, Missouri, eastern Nebraska, southern Iowa; also valleys of Wabash and Kankakee rivers in Illinois and Indiana.

*Bur Oak.*—Valleys of Niobrara and Missouri rivers in Nebraska and South Dakota; immediate vicinity of Devils Lake, N. Dak.; also valley of the Red River of the North.

*Post Oak and White Oak.*—On waste land of gravelly or sandy nature in eastern Oklahoma, Indian Territory, western Arkansas, and on the same sort of land in Illinois, Indiana, and Ohio.

*Ash* (*Green Ash and White Ash*).—Northern Nebraska, eastern South Dakota, southeastern North Dakota, southwestern Minnesota, and western Iowa.

*Tamarack.*—Lake and swamp district of Turtle Mountains, North Dakota; marsh districts of Minnesota, Wisconsin, and Michigan. Not likely to succeed where marshes have been drained in northern Illinois and Indiana.

Of the trees considered, the Hardy Catalpa has better prospects for success, in its section, than any other. This is due to the ease with which it can be managed, its rapid growth, and its adaptability to a large category of uses. That it thrives in but a limited section is to be regretted. Nevertheless, its territory is large enough for great quantities of it to be produced.

Valuable trees other than those mentioned above.—It is freely admitted that there are many trees valuable for planting in the Middle West not included among those given above. All the Elms, Maples, Poplars, and Willows are omitted, and the writer knows well that they have a high silvicultural value; but in a system of forest operations instituted for profit and carried on under competition, such trees can as yet have little place. They have been widely planted and will continue to be planted for shade, shelter, and ornament, but not for profit.. In their influence upon the country they have a high value, and as a class they are not to be lost sight of or disregarded in forest planting; but since this article concerns itself only with those elements that lend themselves readily to the immediate extension of forest operations, a general discussion of these trees is not included.

### EXTENT TO WHICH PLANTING MAY BE CARRIED.

The area for profitable tree planting ten years ago was thought to be limited to the Great Plains. It extends now to sections in the entire

Middle West. Since the profits of timber growing have become manifest, people have become imbued with the tree-planting spirit. There will be more trees planted in the spring of 1901 than have ever been planted before in a single year, but the number to be planted will fall short of the number required. If 500,000 acres of timber should be planted annually, well distributed throughout the Middle West, the production would yet be inadequate to meet the requirements of the country, and the planters could still hope for liberal profits. Ultimately this figure will no doubt be reached.

## METHODS OF PROCEDURE.

### PLANTATIONS ALREADY ESTABLISHED.

The area of planted timber in the Middle West aggregates many hundred thousand acres. Some of this timber is on the decline, some at its best, and some growing into greater value each year. To the last class belong most of the plantations made for profit. Notable among these are the large Catalpa plantations of central and eastern Kansas.

Nearly all of these plantations were established and maintained at first by careful and businesslike methods in the hands of skillful men. Such methods were continued three or four years, and, the young forests well established, the owners thought the battle won and remitted their attentions. The time came for thinning, but it was not done. The trees struggled with one another, and some of the most vigorous managed to thin for themselves by killing their neighbors, but at a great expense to their own growth and vitality. This is true of several of the well-known plantations. They need judicious thinning under the immediate direction of one who fully understands forest operations. Their management from this time on may make a difference of thousands of dollars in their returns. It would be an act of wisdom on the part of the owners to seek the advice of practical foresters in the future management of these plantations.

A large number of plantations have been established within the last three years. From these, excellent returns may be expected, for in almost every case they are in the hands of men who appreciate their importance and know how to manage them properly for the object in view.

Within the last year nearly one hundred plantations have been established in cooperation with the Division of Forestry under its plan of practical assistance to tree planters. In each case an expert of the Division has made an examination of the land, and, after consulting the owner on the objects to be attained, has prepared a plan for the establishment and management of the plantation. Profit has not been the sole object in all cases, but it is a leading feature in nearly all. The Division will direct the management of these plantations from year to year, and it is believed to be possible in this way to make them fully successful and profitable to their owners. Most of them are small, ranging from 5 to 50 acres, but many will be extended over larger areas in the future. (Pl. XV.)

### FUTURE PLANTATIONS.

It may be expected that the plantations to be first established will be small. On individual farms such tracts will be planted to timber as can be spared from annual crops, usually from 5 to 20 acres. Sometimes men of large farms and ample means will afforest 100 acres or more. Larger operations than can be handled with ease and thoroughness should not be attempted. The main object of such plantations should be the production of materials required on the farm and in the immediate locality.

While operations will be carried on generally in small plantations, the time has come when men of means can get large returns from the development of plantations on extended areas. There are reasons for believing that the work can be carried on more successfully by companies than by individuals. The long-time nature of the investment adapts it more especially to company control. The life of a company is permanent, while the life of an individual may cease at any time and throw the investment into hands that fail to carry it out. Companies are also likely to operate on a larger scale than individuals, and large operations will give better returns than small ones. All plantations of this class should be extensive enough to warrant the permanent employment of a resident forester of skill and ability, and should be carried on in sections most suitable to the work. To find such sections is the first step, to fail in which is to fail utterly.

### RAILROAD PLANTING.

The question arises, Since the railroads will be large consumers of timbers that will have to be grown, why should they not establish plantations along their lines? The question has been considered by a number of companies, and operations have been attempted by a few. There is no reason why they should not undertake the work and carry it out successfully. Most of them hold land that is well adapted to forest trees, and by planting tracts of sufficient size to meet their demands, they will greatly reduce their future expenses. It is as practicable for railroads to produce their own timber as it is to mine the coal they use.

### WORKING SYSTEM.

While men may be convinced of the profits in forest plantations, those not familiar with their nature and requirements will find many obstacles to surmount if they attempt, unaided, the work of developing them. The subject is yet too new for men generally to have given

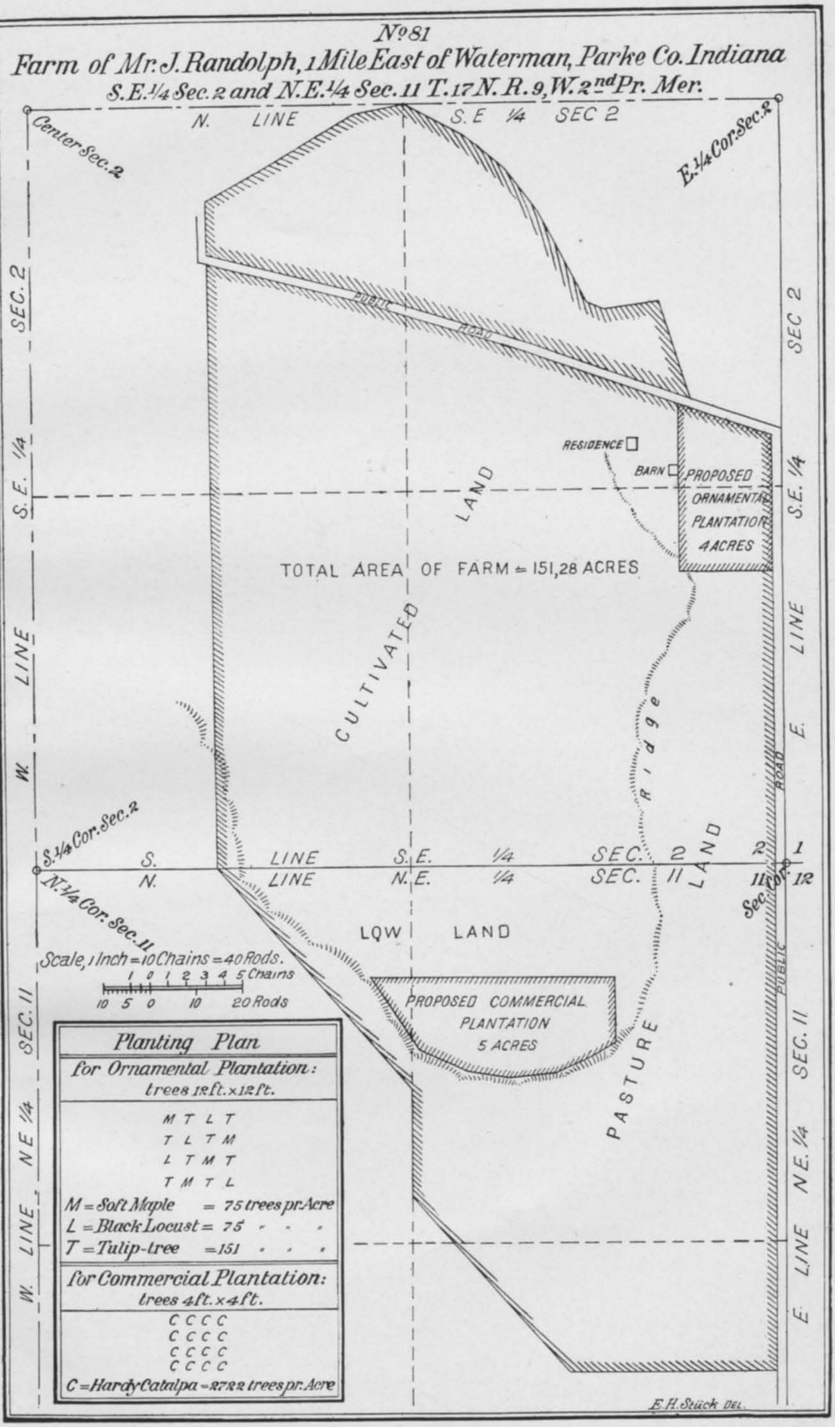


DIAGRAM SHOWING A REPRESENTATIVE PLANTING PLAN FOR A SMALL FARM.

it thorough and exhaustive study. Even farmers have no clear conception of the adaptations of trees to soils or to particular sections of the country, and very few seem fully to understand the best methods of developing a forest plantation. For the individual, these are difficult subjects, requiring both study and travel, but what is difficult for the individual in this case is easy for the Government, which, through the Division of Forestry, can readily investigate the entire subject and determine such matters as sections of adaptation, kinds of trees to be used, and soils and methods best adapted to each species. It is appropriate that this information be supplied free of charge to the person entering upon forest operations, and to this end the Division of Forestry instituted the plan of practical assistance to tree planters. Its purpose from the first has been "to give such aid to planters that wood lots, shelter belts, wind-breaks, and all other economic plantations of forest trees may be so well established and cared for as to attain their greatest usefulness and most permanent value to their owners."

Under the provisions of this plan, the farms of applicants are visited and examined by an expert of the Division, who makes a careful investigation of all conditions affecting tree growth. A planting plan is then prepared for the owner upon the basis of local conditions and requirements. The plan embodies complete and detailed instructions concerning the location, establishment, and management of the plantation. In no case does the Division furnish seeds or trees, or participate in any degree in the expenses of planting and caring for the plantation, but the visit of inspection is always free, and the planting plan is usually without cost to the planter.

### GENERAL RESULTS OF THE COOPERATIVE PLAN.

A careful study of the conditions of the country in connection with this work is convincing that the time is at hand for great extension of timber growing by reason of the returns to be received from it. The sphere for planting is extensive and profits, under good methods, are certain. At the same time the Division of Forestry is able to give more efficient service than in the past, on account of more extensive study of the conditions, needs, and possibilities of the country. It stands ready to advise on choice of soils and kinds of trees, on local obstacles or advantages likely to affect success; to give opinions and advice on lines of forestry that have greatest prospect of profit, as well as to point out regions where such lines can be most propitiously carried out, and to prepare planting plans embodying methods to be followed in the establishment and management of such plantations.

That planters will continue to seek Government cooperation is assured by the great favor which the work is meeting. The visit of the expert forester to an applicant usually has a salutary influence upon the entire community in which he lives. Frequently several plans are made in a community where but one was anticipated. It seems reasonable to hope that the influence of the Division may be thus extended to almost every locality where trees can be profitably grown. Its influence will be not only that of stimulation, but of regulation and direction as well, in all planting operations.

From such a system of forestry will arise maximum returns to the individual and greatest benefits to the community concerned. At the same time the people will become educated to a higher appreciation of the value of forests, and the country at large will gain a unique and valuable accession to its forest system.

# THE WORLD'S EXHIBIT OF LEAF TOBACCO AT THE PARIS EXPOSITION OF 1900.

By Marcus L. Floyd,
*Tobacco Expert, Division of Soils.*

## GENERAL REMARKS.

The cultivation and manufacture of tobacco has become an industry of great importance to every civilized country of the world. Few products of the soil contribute more to the support of the Government than tobacco, and this applies to most countries whether producing or importing. At the world's exhibit in Paris, where all the countries were invited to display the resources and products of their soil, at least thirty countries placed on exhibit leaf tobacco, hoping by this contest to extend their trade and create new demands for their leaf. Many of these exhibits were small, attracting but little attention, as the leaf displayed by them did not represent tobacco of commercial importance.

Among the leaf-tobacco exhibits most worthy of note may be mentioned those of the Dutch East Indies (Sumatra, Borneo, and Java), Cuba, Mexico, Brazil, Turkey, Italy, Japan, France, Germany, Russia, Hungary, Bosnia and Herzegovina, Greece, Servia, Canada, and the United States of America.

## THE EXHIBITS OF LEAF TOBACCO FROM COUNTRIES OTHER THAN THE UNITED STATES.

The countries which produce tobaccos that are imported into our own country and which compete with us for the trade of other nations are the Dutch East Indies, Cuba, Mexico, Brazil, and Turkey. Therefore the tobacco produced by these countries claim our especial attention and consideration. None of the countries above referred to had on exhibition more than 100 samples, nevertheless all the types and grades produced by them were represented. It is just to say that each country showed great care in the arrangement of its exhibit, and the exhibits attracted considerable attention.

### SOME OF THE COUNTRIES EXHIBITING.

Dutch East Indies.—The Dutch Government exhibited tobaccos from Sumatra, Borneo, and Java. The leaf of the island of Sumatra is of a rich light-brown color, very thin and elastic, with small veins, and of desirable size for cigar wrappers. The leaf ranges from 14 to 20 inches, making it serviceable for wrapper purposes, and as a rule it burns freely and gives a clear, white ash. These are the only points of merit that can be justly ascribed to the Sumatra leaf. It does not possess that rich aroma necessary for the filler of a fine cigar. The tobacco farms of the island of Sumatra are largely owned and operated by the Dutch, who spare neither time nor money in the production and care of their crops. Their system of cultivation, harvesting, curing, fermenting, assorting, and baling has in the past led that of every other tobacco-producing country. The tobaccos produced in Java and Borneo are quite similar, but not in any way equal, to those grown in Sumatra. All these tobaccos are controlled by the Dutch, and are shipped to Amsterdam and Rotterdam for marketing.

CUBA.—Although the island of Cuba produces both filler and wrapper leaf of exceedingly fine quality, its exhibit merely consisted of a few carrots[1] of fillers. The Cuban leaf is of a rich brown color, of medium body, and narrow and small in size, ranging from 8 to 18 inches in length. The quality of the best Cuban leaf is recognized wherever fine cigars are made or used, having stood for years without a rival in richness of flavor and aroma.

MEXICO.—Mexico's exhibit was more extensive than that made by Cuba, and the arrangement was a credit to the country. The Mexican leaf, as a rule, is large in size, of dark color and heavy body, with coarse veins and an exceedingly strong flavor. A few carrots were exhibited of wrapper grade that were of desirable size, thin, elastic, and of a beautiful light-brown color. In some respects the Mexican tobacco closely resembles the leaf produced in Cuba, and it is cultivated, harvested, and cured in a similar manner, although the style of the bale is different, except in the smaller grades, which are packed in carrots, as is done in Cuba.

BRAZIL.—The exhibit of Brazil was of leaf produced in that country. This leaf is of medium size, brown in color, and of medium body, possessing fair qualities, but it is poorly handled. Although it is quite popular in Europe (Germany alone controlling about 75 per cent of Brazil's production), the price of this tobacco is from 10 to 12 cents per pound.

TURKEY.—Turkey's exhibit consisted of only one type of tobacco in many grades, that being the world-famed small Turkish leaf. The quality of this tobacco is known and appreciated wherever cigarettes are used. The exhibit was well arranged, attracting considerable attention.

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[1] Packages in which the tobacco is made up, in shape resembling the carrot; hence the name.

ITALY.—Italy exhibited its several types of tobacco. The dark, heavy leaf, similar to that grown in Virginia, is grown from Virginia seed, and the White Burley is produced from Kentucky seed. These types are grown on the dark, heavy, fertile soils of the middle and northern parts of Italy, while on the light, sandy soils of the southern part of the country is produced a leaf from Turkish seed that is quite similar in appearance and quality to the real Turkish tobacco. The method of culture, harvesting, and preparing for the market the heavy, dark tobacco and Burley types is about the same as employed in this country.

JAPAN.—Japan's exhibit may be said to represent only one type of tobacco in many grades, the samples differing somewhat in appearance. This, however, is due to the fact that they represented tobaccos grown in the various tobacco-growing districts of Japan. The leaf is from medium to large size, broad, of a medium, light-mottled color, dry, and poor in quality, suitable only for cigarettes and pipe smoking.

FRANCE.—France exhibited several types of tobacco, all being dark, coarse, and heavy, suitable only for plug and snuff. The French tobaccos are grown principally from Virginia seed. The arrangement of the exhibit was exceedingly fine, a special building being devoted entirely to the display of the leaf tobacco produced in that country.

GERMANY.—Germany exhibited types of tobacco from its two important tobacco-producing sections, Baden and Alsace, the leaf produced in Baden being considered the best. This leaf is from medium to large size, of fair body, heavy, with coarse veins, and not well suited for wrapper purposes, though the tobacco has some quality. It is liked by the Germans and Europeans, and is mainly used for cigars.

RUSSIA.—Russia exhibited several types of tobacco. The installation was poor, and the leaf was not well handled. As a rule, the leaf is exceedingly large, very coarse, dark, heavy, and only suited for plug chewing and snuff. In southern and Asiatic Russia a very good tobacco is produced from Turkish seed. It has a small, bright-yellow leaf, similar in appearance and quality to that grown in Turkey.

HUNGARY.—Hungary's exhibit was very fine, attracting considerable attention. This country produces several types of tobacco which are handled with great care. The dark or heavy type is of a rich dark-brown color, medium size, thin, with small veins, though not elastic. The leaf is dry, possessing some quality; it is used largely for cigar fillers and wrappers. There is also produced a small, bright-yellow leaf, resembling the lemon yellow of North Carolina, though thinner; it is papery, with but little quality. This is used entirely for cigarettes and fine cut for pipe smoking.

BOSNIA AND HERZEGOVINA.—Bosnia and Herzegovina had a well-arranged exhibit. The leaf is from medium to large size, of bright but uneven colors, very dry, possessing but little quality. The same types are produced here as are grown in Hungary, and the leaf is quite similar in appearance.

GREECE AND SERVIA.—Greece and Servia grow only one type of leaf, which was exhibited. This leaf is produced from the Turkish seed, closely resembling the real Turkish tobacco. The resemblance is more especially true of the leaf grown in Servia, where the quality of the leaf is equal to that grown in Turkey.

CANADA.—Canada's display was a creditable one. The leaf is exceedingly large and coarse, produced from Virginia seed, and is only useful for plug and snuff.

## THE UNITED STATES EXHIBIT.

### THE COLLECTIVE EXHIBIT OF THE DEPARTMENT OF AGRICULTURE.

The collective exhibit made by the Department of Agriculture of the United States may justly be considered the largest and most comprehensive display of leaf tobacco ever gotten together. The exhibit was planned by the Secretary of Agriculture and the work of collecting and preparing the same was placed under the immediate direction of Prof. Milton Whitney, chief of the Division of Soils, who was assisted by the writer. In order to obtain good, representative samples of all the types and grades of tobacco produced in this country, each important tobacco-growing section was visited and arrangements made with the leading packers and growers for a full line of samples, which would represent all the types and grades produced in the respective localities. Thus, a collection of nearly 2,000 samples was prepared and exhibited.

### THE TYPES OF TOBACCO IN THE COLLECTIVE EXHIBIT.

MANUFACTURING AND EXPORT TYPES.—The manufacturing and export types, such as are used for cigarettes, fine cut, pipe smoking, plug chewing, and snuff, were fully represented from the States of Maryland, Virginia, North Carolina, Tennessee, Kentucky, and Ohio. Each type and grade was shown, shading in color from the finest bright lemon yellow to the dark mahogany, and from the dark mahogany to the raven black. These samples were carefully graded according to their commercial use, and also classified according to the requirements of both domestic and foreign trade, each sample bearing a label containing this information. The differences in the export types (known to the trade as "foreign"), which are cured and manipulated according to the demands of the various foreign countries, are worthy of special consideration. To the general public such differences are sometimes hardly perceptible, but in the trade the slightest difference in shade, color, thickness, shape, or length of leaf, is taken into account in determining to what country or trade the tobacco is best suited. For example, Great Britain gives preference to a long, narrow, olive-green leaf, which is required to be heavily fired; in fact, the stronger the odor of hard-wood smoke the more acceptable the tobacco is to the British trade. The Austrian Government prefers a long, broad, silky leaf, from medium to light-brown color. The Italian Government uses the same type, only of shorter size and darker in color; while the French prefer a tobacco that has been made exceedingly dark by means of steaming and hard pressure while hot. Thus, each of the foreign countries has different requirements which must be met in the manipulation of our leaf. The tobacco sections displayed much pride in this exhibit, showing great care in the arrangement of the samples contributed. Each foreign country could find in this exhibit leaf selected especially to meet its requirements.

Cigar types.—The finer grades, the cigar types, were represented by samples from the States of Connecticut, New York, Pennsylvania, Wisconsin, Ohio, Florida, and Texas, showing every grade and type of cigar leaf produced in this country. Great care and skill had been displayed by the contributors in the selection and arrangement of the samples. The exhibits of cigar leaf which attracted greatest attention from the general public, and especially from the jury, were made by Ohio and Florida, as will be shown by reference to the awards. Our exhibit of tobacco comprised only the raw leaf, supplemented by a large collection of photographs which showed the various stages of the production of the leaf from seed bed to harvesting and barn curing. In a few instances samples were exhibited illustrating the different stages of the tobacco in the process of manufacture.

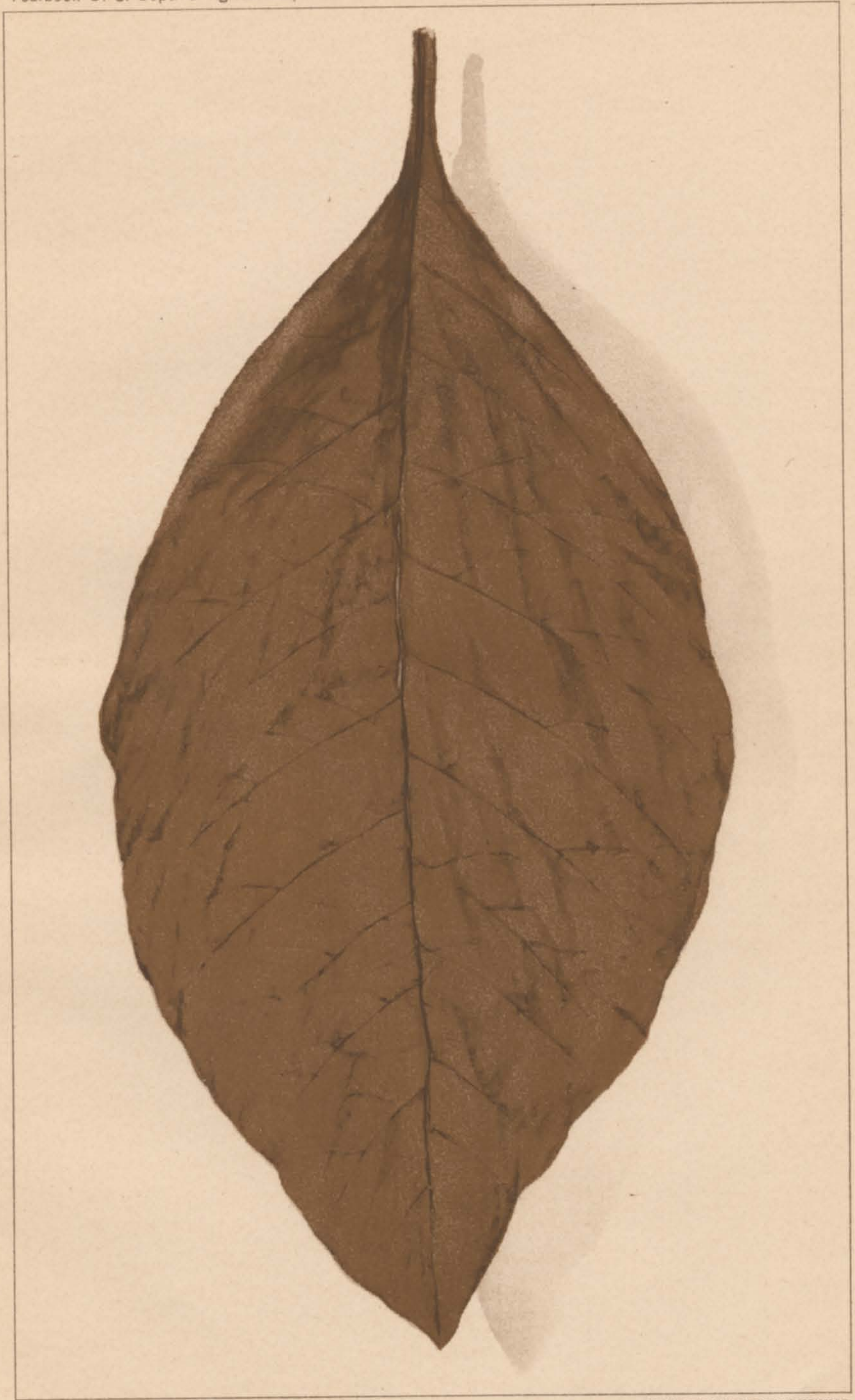
### THE INDIVIDUAL EXHIBIT.

After disposing of the collective exhibit, the jury began the consideration of samples of special types contributed by individuals. There were twenty-five individuals or firms that contributed to the American exhibit, nine receiving gold medals, five silver medals, and the remainder honorable mention. In many other cases the jury would have awarded gold medals, as in the case of the Baltimore Leaf Tobacco Association, the Louisville Leaf Tobacco Exchange, the Cincinnati Tobacco Warehouse Company, and Sutter Brothers, but as the exhibits, which were exceedingly fine, and so recognized by the jury, were by associations and packers who had not declared themselves growers, no special consideration could be shown them under the rules. The exhibit made by the Baltimore Leaf Tobacco Association consisted of a complete line of samples representing all grades of Maryland leaf and the same type of leaf grown in Monroe, Guernsey, Belmont, and Noble counties, Ohio. This tobacco is used exclusively for cigarette and pipe smoking, and is decidedly an export tobacco. France and Germany are our largest customers for this special type. The principal merit of this leaf is its free-burning quality. It is quite thin, and is of a dry nature, having but little flavor or aroma. The exhibit made by the Louisville Leaf Tobacco Exchange and the Cincinnati Tobacco Warehouse Company represented all grades of dark shipping and White Burley tobacco grown in Kentucky and Ohio. The White Burley attracted considerable attention. The leaf is large, bright in color, thin in texture, and is used for plug fillers and wrappers, for fine cut, chewing, pipe smoking, and cigarettes, and is one of the most popular types of manufacturing leaf produced in this country. Owing to the high price paid for this tobacco by American manufacturers, only a small percentage of it finds its way into foreign markets.

TYPES OF TOBACCO LEAF IN THE INDIVIDUAL EXHIBIT TO WHICH AWARDS WERE MADE.

FLORIDA-GROWN SUMATRA LEAF.—The first exhibit in the individual samples to be considered was the display of the Florida-grown Sumatra leaf by the Owl Commercial Company as compared with the leaf grown on the island of Sumatra. In considering these goods much of the preconceived ideas of the merits of the leaf grown in Sumatra had to be overcome. Although this island has stood for years without a rival in the production of a fine cigar wrapper, yet the leaf grown in Florida from Sumatra seed was there to claim superiority, which claim was fully sustained by the jury. Upon investigation, it was found that in appearance and style the Florida-grown tobacco was equal to the Sumatra product; and it was further ascertained that twenty-five more leaves of the Florida-grown leaf of 16-inch size were required to weigh one pound than of that grown in Sumatra, giving to the Florida-grown leaf greater wrapping capacity. The jury voted to the Florida-grown leaf 20 points of merit and to the Sumatra-grown leaf 18 points. (Pl. XVI.)

FLORIDA-GROWN LEAF FROM CUBAN SEED.—The Florida-grown leaf from Cuban seed also received favorable consideration, being voted 18 points of merit against 18 points received by the Cuban product. While the jury recognized that the Florida-grown leaf was a close rival of the Cuban product in point of quality and aroma, the Cuban leaf was found to be richer in flavor and aroma. The jury would have voted to Cuba more points of merit than to Florida had it not been that Florida exhibited leaf grown from Cuban seed that was exceedingly fine for wrapper purposes, whereas Cuba only exhibited filler leaf. These results have not come to the growers of tobacco in Florida by chance, but are the legitimate outcome of well-directed energy and



Baldwin.

A. HOEN & CO. LITHOCAUSTIC, BALTIMORE.

FLORIDA GROWN SUMATRA LEAF TOBACCO.

a liberal expenditure of money. It is a reasonable supposition that in the near future the Florida leaf grown from Sumatra seed will drive from our markets the leaf grown on the island of Sumatra. The leaf grown in Florida and Texas from the Cuban seed is identical in appearance with the best leaf produced on the island of Cuba, giving some evidence of the rich flavor and aromatic quality peculiar to the best tobacco grown on the island. It is a reasonable hope that with the same intelligent work with the Cuban variety that has been expended in the production in Florida of the Sumatra leaf, Texas and Florida will soon produce a tobacco that will doubtless be found fully equal to the leaf grown in Cuba, especially in the medium grades.

Zimmer Spanish and Little Dutch.—The next exhibit that attracted great attention and admiration was that made by Cullman Bros., of Zimmer Spanish and Little Dutch, the seed leaf grown in Ohio and the seed leaf grown in Wisconsin. This display, which represented only fillers and binders, was excellently arranged, and showed the leaf of each type in all its grades. It also showed the raw leaf and the leaf fermented and ready for manufacture. This collection may well be classed as the most unique and comprehensive display at the exposition; and while these types have no special foreign competition, they stood out as tobaccos of excellent quality, being voted by the jury 19 points of merit collectively. Here, too, it is highly probable that with a change of method in the cultivation, harvesting, and curing of the Zimmer Spanish the quality of the leaf could be greatly improved and a tobacco produced that would be quite as acceptable to the smoker as the lower grades of Havana filler.

Connecticut broad leaf and Connecticut Havana seed leaf.—The exhibit made by Sutter Bros. of Connecticut broad leaf and Connecticut Havana seed leaf was in every way a creditable one, receiving great admiration from the jury, which would gladly have given official recognition of the merits of this tobacco as a cigar wrapper had the exhibitors been registered as growers as well as packers of leaf tobacco in the application for representation. This firm also exhibited a full line of samples representing the various grades of leaf produced in the States of Wisconsin, Pennsylvania, and New York. The Wisconsin leaf is used principally as a binder, there being a very small percentage suitable for wrappers except perhaps for cheroots and stogies. The Pennsylvania leaf is large, coarse, and dark, and is only suitable for filler purposes. It would be a much more desirable leaf if it were smaller. The New York product may be said to contain a larger percentage of wrapper leaf than the tobacco grown in Wisconsin, although it is not so acceptable for binder purposes, the quality not being so good.

MANUFACTURING AND EXPORT.—The manufacturing and export types of the exhibit were next considered. These types include cigarette, pipe-smoking, fine-cut chewing, plug, and snuff tobaccos. Of course, the dark tobaccos grown in Tennessee and Kentucky are almost without foreign competition, a fact which is also true of the White Burley grown in Ohio and Kentucky, and the old line of smoking tobaccos grown in Maryland and Ohio. The exhibit made by E. K. Vietor & Co., of Richmond, Va., deserves special mention, as it represented every type and grade of leaf produced in that State, from the raven black to the finest bright lemon yellow. These samples were artistically arranged, showing the leaf to the best possible advantage. Every foreign country that buys Virginia tobacco could find in this exhibit tobacco selected to suit its special requirements. This is also true of the exhibit made by M. H. Clark & Bro., of Clarksville, Tenn. The entire exhibit of the last-named firm was composed of the dark types of Tennessee tobacco—or tobaccos from what is known as the Clarksville district, which includes a part of Kentucky. By special manipulation and selection of the leaf, each foreign country that buys these tobaccos could find in this exhibit samples representing the grades it uses, prepared specially for that particular country.

*Bright-yellow.*—The bright lemon-yellow leaf produced in North Carolina, Virginia, South Carolina, and eastern Tennessee perhaps attracted more attention than any other type of tobacco on exhibit. The largest and most complete display of this type was made by Col. John S. Cunningham, of North Carolina. The cultivation of this tobacco began in 1852 in Caswell County, N. C., and has steadily grown in favor, being especially adapted to the manufacture of cigarettes. It is also very desirable for plug and twist wrappers and fillers. This tobacco was considered by the jury in connection with the Turkish-grown leaf, from which it is quite different in appearance. The Turkish leaf is exceedingly small, from 4 to 8 inches, while our bright lemon-yellow leaf ranges from 12 to 20 inches. The flavor and aroma are quite similar, and when manufactured into cigarettes our leaf is very acceptable to the smoker. Although the jury was inclined to favor the Turkish leaf in point of quality, the fact that the American leaf is useful in many more ways than the Turkish leaf was also recognized. For example, when all-tobacco cigarettes are made our bright lemon-yellow leaf furnishes the wrapper, besides being desirable for plug wrappers and fillers. The Turkish leaf will not yield more than 200 pounds per acre, at a cost of about 50 cents per pound for production, while the lemon-yellow leaf will yield from 800 to 1,200 pounds per acre, and the farmer can make a profitable sale of this at from 18 to 20 cents per pound. With all these facts in consideration the jury voted to the American leaf as many points of merit as to the Turkish leaf, both receiving gold medals. (Pl. XVII.)


Baldwin.

A. HOEN & CO. LITHOCAUSTIC, BALTIMORE.

BRIGHT YELLOW LEAF AND TURKISH LEAF TOBACCOS:
1, BRIGHT YELLOW, VIRGINIA AND NORTH CAROLINA; 2, TURKISH.

### THE JURY AND THE AWARDS.

The tobacco jury was composed of sixteen members, fifteen being foreigners, representing foreign interests, and one American, representing the American interest. As each member of the jury was directly interested either in the production or manufacture of tobacco, each was thoroughly acquainted with tobacco, and could quickly see the merits or demerits of the leaf. As before stated, about thirty countries entered this contest, exhibiting leaf produced by them. The time occupied by the jury in examining the exhibits was about six weeks. After examining the exhibits at the spaces where they were displayed, the jury requested the person in charge of each exhibit to send a line of the best samples to a room prepared for jury work, where a more thorough examination of the leaf was made. These facts are mentioned to show that it was the purpose of the jury to do absolute justice to each exhibit and exhibitor. When the work of examining the various exhibits was completed, during which time each juror made his own notes relative to each exhibit, the voting of awards began, the following scale being used: From one to five points of merit entitled the exhibitor to honorable mention; from six to ten points, bronze medal; from eleven to fifteen points, silver medal; from sixteen to twenty points, gold medal, and from twenty-one to twenty-five points, grand prize. In considering the collective exhibits of leaf tobacco made by all of the countries, it is gratifying to note that the American exhibit was voted twenty-five points of merit by each juror, being the full limit of merit, and giving the grand prize.

### LESSONS OF THE EXHIBIT.

Many of the foreign countries are trying to produce the bright lemon-yellow type of tobacco from our seed, but so far they have failed. The quality and usefulness of this tobacco is recognized, and it is rapidly finding its way into all the markets of the world where cigarettes are made. All the tobacco-producing countries are striving to improve their leaf; and while those sections of our country that produce this type of leaf may be proud of what they have accomplished, it is important that they strive by every means to further improve this product. It is the opinion of the writer that if the seed which produces the bright lemon-yellow tobacco were hybridized with the Turkish seed, good results would be obtained and a more acceptable cigarette tobacco be produced. The fact that to-day America is the greatest tobacco-producing country of the world should not cause us to rest satisfied with what we are now doing. The other countries are sending their agents to this country to study our soil, our climate, and our methods, with the hope that they will be able to produce the types grown here which they use. In like manner we should study carefully the soil, climate, and methods of those countries that supply so much tobacco to our country, and never be content until we have produced here a tobacco that is equal or superior to that of any country in the world. When this is accomplished we will be able to exclude all foreign tobaccos from our markets, and to successfully meet competition in the markets of the world. This can only be done by the farmer acquiring a thorough knowledge of the requirements of the manufacturer, as without this knowledge he works in the dark and his efforts are often misapplied. The countries that have a monopoly of the tobacco industry employ men who thoroughly understand the requirements of the trade to look after the production of tobacco. These men so educate the planter that he knows just what style and kind of leaf is wanted, and makes every effort to produce it. We are, as before stated, annually consuming millions of dollars' worth of tobacco imported from Sumatra, Cuba, and Turkey for the reason that these tobaccos fill a place in our trade that we have so far been unable to fill with any of our domestic products. This has been going on for more than twenty years, and yet, with these products right before us, we have never until within the past few years made any attempt to produce in this country tobacco that would take the place of these imported goods. It has recently been clearly proved that in Florida and Connecticut a leaf can be produced that in every respect equals the imported Sumatra, a leaf that will be quite as acceptable to the trade. Florida and Texas have also in recent years produced from Cuban seed a leaf that is identical in appearance to the leaf produced on the island of Cuba, and while we have not succeeded in getting the exact flavor and aroma peculiar to the best Cuban product we have approached it, and it is reasonable to believe that further improvement can be made. As soon as a foreign agricultural product is introduced into this country and finds a market, it is our plain duty to at once try to produce on our own soil just such an article. Whatever is manufactured in a foreign country that meets with favor in the trade, the American manufacturer at once tries (and generally with success) to produce an article, suited to his trade, of better quality. In like manner the American agriculturist should endeavor to produce whatever types of tobacco are demanded by the trade.

# INFLUENCE OF RYE ON THE PRICE OF WHEAT.

By Edward T. Peters,
*Of the Division of Statistics.*

## WHY THE INFLUENCE OF RYE IS UNDERESTIMATED.

That the price of an article is influenced by the supply, not only of the article itself, but also of other articles which may be used in its stead, is a familiar principle of economics; but, owing perhaps to the insignificance of the rye crop of the United States, the influence of the rye supply upon the price of wheat does not seem to receive in this country the attention to which it is entitled. And what is true of the United States in this particular is true, in a greater or less degree, of most other countries, since rye is not an important crop in any part of the world outside of Europe, and even there it is important in only a minority of countries. Its importance in these latter is, however, sufficiently great to raise it for Europe as a whole nearly to a level with wheat in the extent of its production.

For the five years from 1895 to 1899, inclusive, rye formed 49 and wheat 51 per cent of the combined European crops of these two grains,[1] and the European production of the two together formed 69.5 per cent of the world's production of the same two cereals, so far as the latter is known or has been approximately estimated. Of the world's production of wheat, however, Europe contributed during the same five years only 55.5 per cent, whereas she contributed of the world's production of rye no less than 94.1 per cent. The magnitude of the figures for Europe is, no doubt, somewhat exaggerated by a greater approach to completeness in the crop statistics of European countries than in those of a majority of other countries, and this exaggeration is probably somewhat greater in the case of rye than in that of wheat, for the reason that no attempt has been made to estimate the rye crop in a number of countries whose wheat crop is included with some rough approximation to accuracy in the estimates of the wheat crop of the world. But after all needed allowance is made on this score, the broad fact remains that Europe contributes a much larger proportion of the world's rye crop than she does of the world's wheat crop.

The significance of this fact, in its bearing on the subject under consideration, will, however, become more apparent, if the matter be put in a different form, by saying that while the extra-European countries contribute between two-fifths and one-half of the world's wheat crop,

[1] On the basis of weight the proportion of wheat would be slightly larger.

they contribute, so far as can be determined from the figures available, considerably less than one-tenth of the world's rye crop and less than one-third of the world's total production of these two great bread grains. From this fact, it would only be natural to infer that while the extra-European production of wheat is large enough to have an important influence on the price of breadstuffs, it is not large enough to be a controlling factor.

### RELATION OF THE AMERICAN WHEAT CROP TO PRICES.

How moderate is the influence upon general prices exercised by the great wheat crop of the United States, is a matter of common observation, and this point is well illustrated in the following table, in which the quantity of wheat produced in this country is given for each of the years from 1887 to 1899, inclusive, along with the quantities exported and the average export prices for the corresponding fiscal years:

*Wheat crop of the United States and exports of wheat therefrom.*

| Year. | Wheat crop of the United States. | Exports for the fiscal years, beginning July 1, 1887 to 1899, inclusive. | | | | | |
|---|---|---|---|---|---|---|---|
| | | Wheat exported as grain. | | | Wheat, including flour. | | |
| | | Quantities. | Values. | Average export price. | Quantities. | Values. | Portion of crop exported. |
| | *Bushels.* | *Bushels.* | *Dollars.* | *Cents.* | *Bushels.* | *Dollars.* | *Per cent.* |
| 1887 | 456,329,000 | 65,789,261 | 56,241,468 | 85.5 | 119,624,344 | 111,019,178 | 26.2 |
| 1888 | 415,868,000 | 46,414,129 | 41,652,701 | 89.7 | 88,600,742 | 86,949,186 | 21.3 |
| 1889 | 490,560,000 | 54,387,767 | 45,275,906 | 83.2 | 109,430,467 | 102,312,074 | 22.3 |
| 1890 | 399,262,000 | 55,131,948 | 51,420,272 | 93.3 | 106,181,316 | 106,125,888 | 26.6 |
| 1891 | 611,780,000 | 157,280,351 | 161,399,132 | 102.6 | 225,665,812 | 236,761,415 | 36.9 |
| 1892 | 515,949,000 | 117,121,109 | 93,534,970 | 79.9 | 191,912,635 | 169,029,317 | 37.2 |
| 1893 | 396,131,725 | 88,415,230 | 59,407,041 | 67.2 | 164,283,129 | 128,678,811 | 41.5 |
| 1894 | 460,267,416 | 76,102,704 | 43,805,663 | 57.6 | 144,812,718 | 95,457,591 | 31.5 |
| 1895 | 467,102,947 | 60,650,080 | 39,709,868 | 65.5 | 126,443,968 | 91,735,085 | 27.1 |
| 1896 | 427,684,346 | 79,562,020 | 59,920,178 | 75.3 | 145,124,972 | 115,834,525 | 33.9 |
| 1897 | 530,149,168 | 148,231,261 | 145,684,659 | 98.3 | 217,306,005 | 214,948,377 | 41.0 |
| 1898 | 675,148,705 | 139,432,815 | 104,269,169 | 74.8 | 222,618,420 | 177,363,039 | 33.0 |
| 1899 | 547,303,846 | 101,950,389 | 73,237,080 | 71.8 | 186,096,762 | 140,997,966 | 34.0 |

It will be seen from the above table that the highest average price of the entire period covered followed the largest crop but one produced within the same time, namely, the crop of 1891. On the other hand, the comparatively small crops of 1893, 1894, and 1895 were followed by the lowest prices on record,[1] a much larger crop in 1897 being followed during the fiscal year 1897–98 by a price almost as high as that of 1891–92.

[1] The average export price for the fiscal year 1893–94 (67 cents per bushel) was paralleled in 1826–27, which was the only year from 1816–17 to 1892–93, inclusive, when the average fell below 70 cents per bushel. Even the latter figure was reached in only one year, namely, 1821–22.

### RELATION OF THE AMERICAN WHEAT CROP TO THE WORLD'S SUPPLY OF BREADSTUFFS.

Such a want of correspondence between the size of the American wheat crop and the price of wheat, as above described, is, of course, to be expected, for large as the American wheat crop is, when compared with that of most other countries, it is after all but a minor part of the world's wheat supply and a still smaller part of the world's supply of breadstuffs upon which the price of wheat is more or less dependent. During the five years 1895–1899 it formed 20.4 per cent of the former and only about 13 per cent of the world's supply of wheat and rye together,[1] or rather of that portion of the supply which is included in the published tables on the world's crops. Were it possible to make those tables include all the wheat and rye actually grown, the percentages for the United States would be smaller than those just given. It has, in fact, already been shown that the wheat crop of all countries outside of Europe forms considerably less than half of the world's reported wheat crop, and that their combined wheat and rye crops form less than a third of the world's reported production of these two cereals.

### WHEAT PRICES AND THE WORLD'S WHEAT CROP.

Even when it is fully recognized that the comparatively small dependence of the price of wheat on the size of the American crop is only what might be expected under the circumstances, it may still seem at first sight that this price ought to be controlled by the size of the world's crop of that grain. It is, however, found on comparing the average export prices of wheat shown in the table on page 173 with the published figures on the world's wheat crop, that the connection between large crops and low prices, and on the other hand, between small crops and high prices, is by no means so close and continuous as might be supposed. In fact, if attention is confined to the wheat crop, it is found that the price of that grain shows in some cases a much closer connection with the size of the European wheat crop than with that of the wheat crop of the world. This is especially noticeable in the price for 1891–92, following the European crop failure of 1891, which was 10 per cent higher than that for the preceding year. Such an increase, it would seem, must have been due to a considerable decrease in the supply; but while there was a large decrease (some 200 million bushels) in the wheat crop of Europe, there was none, but on the contrary a small increase, in the wheat crop of the world. It would be a mistake, however, to infer that the European deficiency in the wheat supply was the cause of the increase in price.

[1] If the rye crop of the United States were added to the wheat crop of the same, the percentage of the world's total would be raised from 13 to 13.7.

EFFECT OF VARIOUS FOOD CROPS ON THE PRICE OF WHEAT.

The true explanation is that while there was no general deficiency in the world's supply of wheat, considered as a single cereal, there was such a deficiency in the world's supply of breadstuffs. Of these breadstuffs, wheat, albeit the most important, is only one; and being largely interchangeable with others, above all with rye in a large part of Europe,[1] it is affected in price by the supply of bread grains in general, and to some extent even by the supply of substitutes for bread, particularly potatoes. Had the European scarcity of 1891 been confined to wheat, it would have been fully counterbalanced by the abundance of that grain elsewhere, and instead of a rise in its price there might have been a slight fall; but the same conditions which caused a failure in the European wheat crop affected various other important European food crops. In Russia, where some provinces suffered a scarcity approaching famine, there was a deficiency not only in wheat, but in rye, barley, oats, potatoes, and several minor food crops. In Germany the failure affected rye, spelt, and potatoes, as well as wheat. In both of these countries the effect of the bad season on the rye crop was a matter of far more serious import than its effect on the wheat crop, for the reason that the former cereal is far more extensively grown and far more largely depended on as a bread grain than is the latter. It has been shown that in the whole of Europe, rye, during the five years 1895–1899, formed 49 and wheat 51 per cent of the total production of the two grains; but in European Russia rye formed, during the same period, 67.3 per cent and wheat only 32.7 per cent of the production of the same two cereals, while in Germany the preponderance on the side of rye was still greater, the percentage being 72.3 against 27.7 per cent of wheat. In the Scandinavian countries, the Netherlands, Belgium, and Austria, as well as in Russia and Germany, rye is a more important bread grain than wheat.

THE DEFICIENCY OF BREADSTUFFS IN 1891.

It is, of course, conceivable that even in large rye-growing countries unfavorable conditions might be confined to districts in which wheat greatly preponderates, and that a short wheat crop might thus be accompanied by a good rye crop in such countries; but a case of this

[1] In the United States it is interchangeable with maize to a considerable extent, but in most of the bread-eating nations this is not the case. There is, of course, a large demand for wheat which is not readily satisfied by any substitute, and a like remark will apply to the other great food stuffs, but there is apparently a considerable percentage of the bread-eating populations among whom the preference for one grain over another is not so strong as to hold out against any very considerable advantage in the way of cheapness on the side of the less-favored product; and this percentage is probably larger in the great rye-producing countries than elsewhere.

kind would be decidedly exceptional, and such a case did not occur in the year under consideration (1891), for not only in Russia and Germany, as already pointed out, but in a number of other countries in which rye preponderates over wheat, did the former suffer along with the latter. Statistics of the rye crop for the somewhat extended period under consideration are not at hand for the whole of Europe, but an indication of the extent of the failure of this grain in 1891 may be seen in the figures for Russia and Germany, which together produce something like three-fourths of the rye crop of the commercial world. In 1890 the rye crop of these two countries[1] amounted to 949,987,000 bushels, against 728,357,000 bushels in 1891, the deficiency in the latter year, as compared with the preceding one, being 221,630,000 bushels, or nearly 22,000,000 bushels greater than the deficiency in the wheat crop of the whole of Europe.

About 65 per cent of the total deficiency in the European wheat crop of 1891 occurred in countries where wheat is the chief bread grain.[2] Had the remaining 35 per cent been made up by other countries of the same class, the extent of the deficiency in wheat might substantially have measured the extent of the European deficiency in breadstuffs, in which case, being more than offset by an extra-European surplus, it should have been attended by a fall rather than a rise in their price. But in the actual case, the unfavorable conditions which characterized the season in great wheat-growing countries like Hungary and France, affecting the supply of breadstuffs there chiefly through the failure of that grain, chanced, as already shown, to extend into countries where, besides affecting that supply through the failure of wheat, they affected it in a far greater degree through a failure of other bread grains, especially rye, thus producing a total effect upon the supply of breadstuffs which the extra-European wheat surplus was very far from counterbalancing. The deficiency in the European bread grains other than wheat can scarcely have been less than 250,000,000 bushels, for the deficiency of rye alone in Russia and Germany amounted in round numbers to 222,000,000 bushels. Hence, if the deficiency of 200,000,000 bushels in the European wheat supply be also taken into account, there is a total deficiency of 450,000,000 bushels in the European supply of breadstuffs, a deficiency against which the extra-European countries had substantially nothing to set except their surplus[3] of wheat, amounting to only 258,000,000 bushels, and

[1] Including in the case of Russia only the 50 governments of European Russia proper and the 10 governments of Russian Poland.

[2] About that proportion of the total deficiency was occasioned by the wheat crop failure in Hungary and France, deficiencies in other countries of that class being about balanced by surpluses in Italy and Spain.

[3] It will be kept in mind that the deficiencies and surpluses here under consideration are those of the year 1891 as compared with 1890.

thus leaving a net deficiency of nearly 200,000,000 bushels in the world's supply of bread grains, a deficiency which satisfactorily explains a material increase in price.

### PRICE MOVEMENT AND VARIATION IN SUPPLY.

While the figures just given refer to the year 1891, as compared with 1890, the correctness of the views advanced is, on the whole, sufficiently well attested by the figures for other years. Statistics for all the bread grains, or, indeed, for any except wheat, are not available for the whole commercial world for all the years for which the average export price of wheat has been given. It has, however, been seen that of these grains rye is next to wheat in importance and that nearly three-fourths of the world's rye crop is produced in two countries, namely, Russia and Germany; hence, if the rye crop of these two countries be added to the wheat crop of the world, there will be a much closer approach to the world's supply of breadstuffs than is made by taking the wheat crop alone; and comparison will show that in most cases there is also a much closer approach to a satisfactory explanation of the movement of prices in harmony with the law of supply and demand. This will sufficiently appear upon examining the table to be next presented, in regard to which it must, however, first be explained that the figures it contains on the world's wheat supply are made up by adding to the crop of the Northern Hemisphere for each year one-half of the preceding and one-half of the succeeding crop of the Southern Hemisphere. The reason for this procedure will be readily perceived. The years for which prices are given in the table, being the fiscal years beginning on July 1 of the years 1887 to 1899, inclusive, commence about the same time with the harvest of the Northern Hemisphere, and the crop reaped in that harvest is substantially the one marketed and consumed during the fiscal year.[1] On the other hand, the contribution of the Southern Hemisphere to the supply for the first six months (July to December) of such year must come out of the crop reaped in the preceding winter (that is, in the preceding southern summer), whereas its contribution to the supply for the other six months (January to June) must come mainly out of the crop reaped a year later, that is, in the closing weeks of the calendar year in which the given fiscal year begins and the opening weeks of that in which it ends. It is obvious, therefore, that by the method adopted the actual supply for each fiscal year is more closely approximated and the relation of supply to price more accurately indicated than by taking either the whole crop reaped in the Southern Hemisphere in the middle of

[1] It would be interesting to consider in this connection the stocks carried over from one year to another, but the lack of trustworthy records covering so long a period renders that impracticable.

the given fiscal year or that reaped a year earlier. It may be added that while the figures presented as the world's wheat supply can not be taken as including all the wheat grown, they include either official returns or the best attainable estimates for the countries contributing appreciably, either as importers or as exporters, to the wheat movement of the commercial world. The following is the table:

*Movement of supply and of average export price.*

| Year. | World's wheat supply. | Wheat supply plus rye crop of Russia and Germany. | Average export price of wheat in the United States for fiscal years beginning July 1, 1887, to 1899, inclusive. | Increase (+) or decrease (−) in world's supply. | | Average export price of wheat in the United States. |
|---|---|---|---|---|---|---|
| | | | | Wheat alone. | Wheat plus rye crop of Russia and Germany. | |
| | *Millions of bushels.* | *Millions of bushels.* | *Cents.* | *Per cent.* | *Per cent.* | *Per cent.* |
| 1887 | 2,485 | 3,530 | 85.5 | | | |
| 1888 | 2,439 | 3,411 | 89.7 | − 1.9 | − 3.4 | + 4.9 |
| 1889 | 2,302 | 3,102 | 83.2 | − 5.6 | − 9.1 | − 7.2 |
| 1890 | 2,377 | 3,327 | 93.3 | + 3.3 | + 7.3 | +12.1 |
| 1891 | 2,435 | 3,163 | 102.6 | + 2.4 | − 4.9 | +10.0 |
| 1892 | 2,490 | 3,407 | 79.9 | + 2.3 | + 7.7 | −22.1 |
| 1893 | 2,570 | 3,652 | 67.2 | + 3.2 | + 7.2 | −15.9 |
| 1894 | 2,646 | 3,840 | 57.6 | + 3.0 | + 5.1 | −14.3 |
| 1895 | 2,577 | 3,654 | 65.5 | − 2.6 | − 4.8 | +13.7 |
| 1896 | 2,498 | 3,597 | 75.3 | − 3.1 | − 1.6 | +15.0 |
| 1897 | 2,252 | 3,195 | 98.3 | − 9.8 | −11.2 | +30.5 |
| 1898 | 2,982 | 4,046 | 74.8 | +32.4 | +26.6 | −23.9 |
| 1899 | 2,762 | 3,976 | 71.8 | − 7.4 | − 1.7 | − 4.0 |

It will be noted that the figures for 1891 (fiscal year 1891–92) show an increase of 2.4 per cent in the world's wheat supply, along with an increase of 10 per cent in the price, but, as already pointed out, there was a decrease in the supply of breadstuffs, and this is indicated by the figures on the world's wheat supply plus the Russian and German rye crop, which show a decrease of 4.9 per cent. In all the other years except 1889, 1890, and 1899 (fiscal years 1889–90, 1890–91, and 1899–1900), an increase in the supply is attended by a decrease in the price, and a decrease in the supply by an increase in the price, just as might be expected; but it may be noticed that with three exceptions (years 1889, 1890, and 1896), the change in the price corresponds more nearly to the change in the world's wheat supply plus the Russian and German rye crop than to the change in the world's wheat supply alone.

## EXTENT OF EFFECT ON PRICES.

It will be seen that in nearly all cases the change in the price is considerably greater than the change in the extent of the supply. Thus, the figures for 1888 (fiscal year 1888–89) show that a decrease of 1.9 per cent in the world's wheat supply and 3.4 per cent in that plus the rye crop of Russia and Germany is attended by an increase of 4.9 per cent in the average export price. If the next two years be for the present passed over, it will be found that in 1891 (fiscal year 1891–92) a decrease of 4.9 per cent in the world's wheat supply plus the rye crop of the two countries just named was attended by an increase of 10 per cent in the price. For that year there was an increase in the world's wheat supply considered alone, but, as already pointed out, the decrease in the total supply of breadstuffs accounts satisfactorily for a rise in price. The figures for the next year show an increase of 2.3 per cent in the world's wheat supply, and 7.7 per cent in that plus the Russian and German rye crop, with a decrease of 22.1 per cent in the price. So also for each of the subsequent years, except 1898 and 1899, the fall or rise in price is considerably more than proportional to the increase or decrease in the supply for the corresponding year. A similar relation between crops and prices has been observed by various writers, and Tooke, in his History of Prices,[1] especially points out that, while no definite ratio or series of ratios has been found to exist between changes in supply and the converse changes in price, "a decided deficiency of supply is commonly attended in the case of corn [i. e., wheat], more than in that of most other articles, with an advance in price very much beyond the degree of the deficiency." He also adds[2] "that an excess of quantity operates in depressing the prices of commodities generally, but of corn [wheat] more especially, in a ratio much beyond the degree of that excess." Greatly as conditions have changed in many respects since this was written, it is not surprising that Tooke's conclusion upon the point in question should find support in the figures now under consideration, because the demand for breadstuffs is still a comparatively inelastic one, diminishing but little in years of scarcity and expanding but little in years of abundance as compared with the demand for many other commodities. Increased facilities for transportation have rendered it comparatively easy to use the surplus of one locality to relieve scarcity in another, and thus greatly to moderate the fluctuations of prices, but in connection with a general scarcity or a general superabundance the tendency observed by Tooke seems still to manifest itself.

## SOME APPARENT ANOMALIES CONSIDERED.

Returning to the years 1889 and 1890, which have not yet been discussed, it may be noted that in the former year there appears to have been a decrease of price in connection with a decrease in the

[1] Page 13, vol. 1, edition of 1838.

[2] Tooke's History of Prices, vol. 1, edition of 1838, p. 17.

supply, and in the latter an increase in price in connection with an increase in the supply, the result in each case being the opposite of that which the law of supply and demand requires. But even if the requirements of that law in respect to the precise relations between supply and price under any given conditions were definitely known, such figures as those in the table on page 173 could not be expected to exemplify them with any close approach to exactness, for the reason that a large allowance must be made for the influence of factors not shown in that table, such as variations in the stocks held over from year to year, in the size of various supplementary food crops, and in the cost of transportation, to say nothing of the margin of error necessarily existing in all estimates of the world's crops. An examination of the facts for the two years in question (1889 and 1890, fiscal years 1889-90 and 1890-91) brings to light the existence of circumstances, additional to those shown in the table on page 173, tending to exert just such an influence on prices as appears from the figures on that subject to have been exerted, and thus serving to explain the seemingly anomalous relation between the figures on supply and the figures on price for those years.

Among the circumstances just referred to may first be mentioned the fact that the deficiency of 1889 as compared with 1888, both in the world's wheat supply alone and in that plus the Russian and German rye crop, was mainly due to the short crop of both of these grains in Russia. This will appear from an inspection of the following crop figures:

*Relation of Russian crop failure of 1889 to world's bread supply.*

| Year.[a] | World's wheat supply. | Wheat supply plus Russian and German rye crop. | Crop of European Russia (60 governments). | | Russian exports.[b] | |
|---|---|---|---|---|---|---|
| | | | Wheat. | Wheat and rye. | Wheat. | Wheat and rye. |
| | *Millions of bushels.* | *Millions of bushels.* | *Millions of bushels.* | *Millions of bushels.* | *Millions of bushels.* | *Millions of bushels.* |
| 1888 | 2,439 | 3,411 | 310 | 1,065 | 122.4 | .......... |
| 1889 | 2,302 | 3,102 | 189 | 778 | 102.4 | 145.6 |
| 1890 | .......... | .......... | .......... | .......... | 104.0 | 149.6 |
| 1891 | .......... | .......... | .......... | .......... | 50.5 | 64.5 |
| 1892 | .......... | .......... | .......... | .......... | 84.0 | 96.0 |
| Decrease in crop, 1889, compared with 1888 | 137 | 309 | 121 | 287 | .......... | .......... |

[a] The crops are for the several calendar years, the exports for the twelve months beginning August 1 of the years named.

[b] For discussion of Russian exports, see pp. 176 and 177.

Of the decrease in the world's wheat supply, the decrease in the Russian wheat crop accounts for 88.3 per cent, and of the decrease in the world's wheat supply plus the Russian and German rye crop, the Russian decrease in wheat and rye accounts for 92.9 per cent.

### LOCAL SCARCITY AND GENERAL PRICES.

How far a local scarcity will affect general prices depends on the extent to which the general supply is drawn upon for its relief. If through remoteness from lines of transportation or through a degree of poverty which prevents its people from buying sufficient food, a district in which scarcity exists remains unrelieved, scarcity in such a case may cause the severest local distress without having any effect upon prices at the great centers of exchange; and in proportion as such a condition of things is approximated, the effect of local scarcity upon general prices will be slight. Now, there are districts in Russia in which such a condition is approximated in a greater or less degree after most bad harvests. In 1889-90 local distress was probably mitigated by the existence of stocks of grain held over by the cultivators out of the abundant crops of the two preceding years; but however this may have been,[1] it is obvious that the districts in which the crops had seriously failed did not on the whole draw very heavily on the surplus of those in which they had been good, for the reduction in exports was insignificant in comparison with the reduction in the crop. It will be seen by referring to the table on page 175 that the exports of wheat from Russia during the twelve months beginning August 1, 1889, following the scanty harvest of that year, were only 20 million bushels less than during the twelve months following the bountiful one of 1888, which yielded a crop 121 million bushels larger. Figures on the exports of rye for the year beginning August 1, 1888, are not at hand, but the exports for the calendar year 1888 were only 69 million bushels, those for the calendar years 1889 and 1890 showing decreases of 15 million bushels and 4 million bushels, respectively.

From these figures it is evident that any decline in exportation from Russia after her short rye crop of 1889 must have been insignificant as compared with the decrease in the rye crop itself, which was 166 million bushels smaller than that of 1888. On the other hand, Argentina, out of the abundant harvest reaped in the closing weeks of 1889 and the opening ones of 1890, began to export freely during the last half of the fiscal year 1889-90, and the wheat exports of the United States were over 20 million bushels greater than those of the preceding year, the wheat crop of 1889 having been the largest of the five harvested in the years from 1885 to 1889, inclusive.

On the whole, it would seem that while the world's production of breadstuffs was considerably less in 1889 than in 1888, the deficiencies were largely at points somewhat remote from transportation, and either remained in great part unsupplied or were supplied out of the stocks

[1] A considerable residuum of unrelieved distress is suggested by the official record of deaths, which shows a noticeable increase in the death rate. As might be supposed, a much larger increase followed the great crop failure of 1891.

held over from the large crops of 1888 and 1887, while the more important surpluses were favorably situated for finding their way into the channels of commerce. In point of fact, the wheat actually thrown into those channels for the supply of the importing countries was increased rather than diminished, as may be seen by an inspection of the imports of those countries for 1888, 1889, and 1890; and if to this fact we add that the potato crop of 1889 was almost universally good, being about one-seventh greater than that of 1888,[1] a fall in the average export price of wheat ceases to be surprising.

### PRODUCTION AND EFFECTIVE SUPPLY.

The explanation just offered for the fall of price in 1889–90, after the smaller crop of 1889, implies that, notwithstanding the decrease, the effective supply of breadstuffs and acceptable substitutes therefor available at the great centers of exchange was really greater than in 1888–89 after the larger crop of 1888. It may, therefore, easily have been larger than the effective supply of 1890–91, for the crop of 1890 was not so large as that of 1888; and in that case the rise in price in 1890–91 would, of course, be a natural result of a diminished effective supply. There are, in fact, independent reasons for concluding that the effective supply at the centers of exchange was really smaller in 1890–91 than in 1889–90, notwithstanding that the wheat and rye crops of these years stood to each other in just the opposite relation. The exceptionally large potato crop of 1889 has been noticed as a probable element in the supply of foodstuffs by which the price of wheat was determined in 1889–90. In the twelve countries whose returns on production were considered in that connection the crop was over 300 million bushels, or nearly 10 per cent, less in 1890 than in 1889. Moreover, an examination of the import and export statistics of countries which contributed most largely to make the figures for 1890 on the world's crops of wheat and rye higher than those for 1889[2] seems to warrant the conclusion that, in the case of exporting countries, there was no increase in exports and, in the case of importing ones, no diminution in imports corresponding to the increase in the crops. In Russia the crop of 1890[3] exceeded that of 1889 by 37 million bushels in the case of wheat and 130 million bushels in that of rye, making 167 million bushels in the two grains, whereas the exports of both for the twelve months following the more bountiful harvest were only 4 million bushels greater than for the twelve months following the scantier one. (See

[1] This estimate is based on the returns for twelve countries, embracing all those in which the potato crop is an important one.

[2] Particularly Russia, Germany, Austria-Hungary, and France, which together produced over 140 million bushels more wheat and nearly 176 million bushels more rye in 1890 than in 1889.

[3] In the 60 governments comprised in European Russia proper and Poland.

table on page 175.) In France an increase of more than 24 million bushels in the wheat crop not only failed to cause any decrease, but was actually followed by an increase in the net imports, which were nearly 12 million bushels greater during the crop year 1890–91 than they had been during the preceding one.[1] In Germany and Austria-Hungary, taken together, the crop of 1890 exceeded that of 1889 by about 80 million bushels of wheat and 43 million bushels of rye, making 123 million bushels of the two grains; but the imports and exports of these countries show no corresponding changes, such changes as occurred appearing on the whole to have been rather in the opposite direction.[2] These cases are in part offset by that of the United States, in which a diminution of 91 million bushels in the wheat crop was followed by a diminution of only 3 million bushels in the quantity of wheat exported, including flour reduced to its wheat equivalent; but if rye be taken into account the increase in the crop of the two grains in Russia alone, to say nothing of the other countries named, exceeded the decrease in the wheat crop of the United States by more than 70 million bushels, while the slight increase in the Russian exports fell about a million bushels short of balancing the slight American decrease. In short, the figures pretty clearly indicate that, as in 1889–90, there were deficiencies for which no demand of a corresponding magnitude was made upon the general supply of breadstuffs, so in 1890–91 there were surpluses out of which that general supply received no correspondingly large contributions.

### ADVANCE EFFECTS OF CROP FAILURE OF 1891.

There is no doubt that both the commercial movement and the price of bread grain for the fiscal year 1890–91 were considerably affected by the bad outlook which forewarned the world of the great European crop failure of 1891; for as the failure was largely in winter grain,[3] it was foreseen for several months before the harvest. A statement from the European agent of the Department of Agriculture made in February, 1891, shows that the bad crop prospect was already beginning to show its effects in "a general stiffening of prices" in the British and Continental markets; and an examination of the wheat quotations for the period shows a marked rise about the beginning of April, with a comparatively high level of prices during that and the two following

[1] See Broomhall's Corn Trade Year Book for 1895, p. 47, for net imports for years ending July 31, 1890 and 1891. The crop figures are official.

[2] Figures on imports and exports for these countries are not at hand for the twelve months immediately following the harvest, but the official statistics for the calendar years 1889, 1890, and 1891 seem to justify the conclusion stated.

[3] The deficiency in the Russian crops of winter wheat and winter rye in 1891, as compared with 1890, amounted to about 190 million bushels, to say nothing of the winter-grain crops of other countries.

months. So, also, it is found that whereas the average export price of wheat for the fiscal year 1890–91 was 93.3 cents per bushel, the average for the first eight months (July, 1890, to February, 1891, inclusive) was about 88 cents; from which it follows that the 42,132,046 bushels exported during the four months from March to June, 1891, must have averaged about $1.01 per bushel, or 13 cents per bushel more than that exported during the preceding eight months.

The average gazette prices of wheat in Great Britain show the effect of the bad outlook for the harvest of 1891 as plainly as do the average export prices of American wheat. The average price for the first eight and the last four months of the fiscal years 1889–90 and 1890–91 and for each of these years is given in the following table, with the increase in price in 1890–91 as compared with the previous year:

*Average price of wheat in 1889–90 and 1890–91, with increase in 1890–91.*

| Period. | Average price per bushel. | | Increase. | |
|---|---|---|---|---|
| | 1889–90. | 1890–91. | 1890–91. | |
| | *Cents.* | *Cents.* | *Cents per bushel.* | *Per cent.* |
| First eight months | 88.3 | 95.7 | 7.4 | 8.4 |
| Last four months | 91.4 | 112.1 | 20.7 | 22.6 |
| Entire fiscal year | 89.4 | 100.8 | 11.4 | 12.8 |

The extent to which the high average for the year 1890–91 was due to the sharp advance during the last four months of that year (March to June, 1891) is plainly shown by the above figures, and that advance was recognized at the time as an effect of the bad outlook for the harvest then approaching.

## THREE ANOMALOUS CASES.

For the year 1896 (fiscal year 1896–97) the rise in the price formed a percentage more than four times as great as did the deficiency (compared with the previous year) in the world's wheat supply and nearly ten times as great as did the deficiency in that plus the Russian and German rye crop. This is one out of three of the years covered by the table on page 173, in which the export price of wheat seems to conform more closely to the wheat supply alone than to that plus the Russian and German rye crop. It will be seen by referring to the columns of that table giving increase or decrease in the crop that for five years in succession preceding 1895 there had been an increase in the world's wheat supply and for three years a continuous and much larger increase in wheat and rye together, the latter being chiefly due to three successive increases in the Russian rye crop. It is reasonable to suppose that out of these abundant crops Russian farmers had retained a considerable quantity, especially as prices had been low, and a recollection of the sufferings which had been endured through the great crop failure of 1891 would suggest the wisdom of being prepared for emergencies. If it be supposed that the stocks carried over by farmers in Russia and other parts of the world were as much as 70 million bushels in excess of the amount carried over in ordinary times (a supposition by no means extravagant) the figures on supply (including the Russian and German rye crop) for 1895 will be raised from 3,654 to 3,724 million bushels, the percentage of decrease in supply of the two grains being thus reduced from 4.8 to 3 for 1895 and raised from 1.6 to 3.5 for 1896.

On comparing these two tentative percentages of decrease in the supply of wheat and rye with the percentages of increase in the export price of wheat for the same two years, they are found to be somewhat smaller than might have been expected; but they, nevertheless, show on the whole a much more reasonable relation between decrease of supply and increase of price than is exhibited by the figures for those years given in the table. It may be noted, too, that with the adjustment suggested the price for 1896 conforms more closely to the supply of wheat and rye than to that of wheat alone, just as it has been seen that it does in most other years.

Of course, no claim to statistical exactness can be made on behalf of the adjustment in question, but that the rye crop in 1895 was supplemented to an unusual extent by stocks held over from the large crops of the preceding years, admits of no reasonable doubt; and though rye itself was exported from Russia in very moderate amounts, either during 1895–96 or the two more abundant years preceding it, the abundance of the rye crop was an essential condition to the heavy exports of wheat which Russia was able to make during 1893–94 and 1894–95, and which, in spite of diminished crops of both grains in 1895, she was able (out of her accumulated stocks) to maintain with a comparatively small diminution through 1895–96.

Large as was the fall of price in 1898 (fiscal year 1898–99), it seems hardly proportioned to the enormous increase in the supply for that year; but it must be remembered that a considerable percentage of this large increase was needed to restore reserved stocks to something like their normal proportions after the extreme depletion due to the short crop of 1897.

For the year 1899 (fiscal year 1899–1900) the movement in the average export price is in the opposite direction to that which the figures on supply would indicate. It amounts, however, to a decrease of only 4 per cent; and while that would seem hard to reconcile with a decrease of 7.4 per cent in the world's wheat supply, the anomaly becomes much less marked if the decrease of 4 per cent in the price be considered in connection with the small decrease of 1.7 per cent in the world's wheat supply plus the Russian and German rye crops, a decrease which would retain about the same proportion if the figures on the world's rye crop, so far as known, should be substituted for those on the rye crops of Russia and Germany. In short, 1899, in spite of the anomaly presented by the price movement, is one of the years in which the influence of the rye crop on the price of wheat is quite distinctly traceable.

Moreover, the anomaly in question might entirely disappear if the extent to which the crop of 1898 was drawn upon to replenish depleted stocks could be fully shown. The draft upon that crop for the purpose just specified has already been mentioned as a reason why the fall in the average export price of wheat in the fiscal year 1898–99 was not in fair proportion to the increase in the figures on supply. It is equally valid as a reason why the price movement of the following fiscal year does not correspond with the change in the figures on supply, for it really means that the effective supply for consumption in 1898–99 out of the crop of 1898 was not so large as the figures in the table on page 173 would make it appear. In so far as this was the case, the effective supply increased less as between 1897 and 1898 and decreased less as between 1898 and 1899 than the figures in the table indicate, if taken as they stand. It is, in fact, altogether probable that instead of the decrease of 70,000,000 bushels shown by a comparison of the figures for 1899 on the world's wheat supply plus the Russian and German rye crop, with the figures for 1898 on the same subject, there was actually some increase; and a very small increase would suffice to explain the fall of 4 per cent in the average export price of wheat.

That the crop of 1898 was in fact largely drawn upon to replenish depleted stocks is shown by a comparison of the figures on stocks of wheat for corresponding dates in the years 1897–98 and 1898–99. On July 1, 1898, after the short crop of 1897, the available stock of Europe and America amounted in round numbers to only 80,000,000 bushels, whereas a year later it had risen to 119,000,000 bushels—an increase of 39,000,000 bushels. A much larger increase must, however, have occurred in the amount in the hands of farmers, for in the United States alone this part of the reserve stock rose from 18,000,000 to 64,000,000 bushels. This is an increase of 46,000,000 bushels, which added to the increase of 39,000,000 bushels in the stocks known technically as "available," gives a total increase of 85,000,000 bushels, or enough to convert the apparent decrease of 70,000,000 bushels in the supply of wheat and rye for 1899–1900 into an actual increase of 15,000,000 bushels. If to this were added the increase in the stocks in farmers' hands outside of the United States, there would remain no reason to doubt that the effective supply available for 1899–1900, instead of being smaller than that of the previous fiscal year, was really enough larger to account satisfactorily for the decrease of 4 per cent in the average export price of wheat.

### OBSTACLES TO EXHAUSTIVE TREATMENT.

To treat the subject thoroughly would doubtless require that some allowance should be made for the annual increase of population, and that the relations between price and supply should be more closely followed from year to year, reasons being sought for any apparent disproportions between the changes in supply and the converse changes in the price, or at least for any irregularities in the extent of such disproportions. It would also be interesting to consider not only the world's wheat crop and that portion of the world's rye crop actually included in the table on page 173, but the whole of the world's crop of rye and also of other products serving to any considerable extent as substitutes for wheat when relatively more abundant and hence cheaper than that grain. The statistics necessary to an exhaustive treatment of the subject are, however, not easily obtainable. Statistics of wheat have been more fully and carefully compiled than those of any other widely cultivated food crop, but even these are composed to a considerable extent of unofficial estimates of the production of countries in which no official statistics are collected, and, taken as a whole, the annual estimates of the world's wheat crop can be regarded only as rough approximations to the truth—approximations, too, which vary from year to year in the nearness of their approach to accuracy, thus producing irregularities which alone would forbid the expectation of any very exact quantitative relation between the variations in reported supply and the variations in price.

The most that could reasonably be attempted with the incomplete data at command was the detection of some of the more prominent relations between causes and effects, and this purpose is fairly well served even by the limited data herein used. The broad general correspondence between the movement of the average export price and the changes in production, the modifying influence of the rye crop and to some extent that of other grain crops and of potatoes, and the variation in the influence of deficits and surpluses according as the localities in which they occur are well or ill provided with transportation facilities, or according to other local circumstances, might perhaps all be anticipated upon a priori grounds; but some of them have hitherto been largely overlooked, and the indications of their presence and effective operation afforded by the figures above presented are certainly worthy of attention.

# MOUNTAIN ROADS.

By James W. Abbott,
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## INTRODUCTION.

It may be stated as a general proposition that practically every mountain road west of the Missouri River has been built to meet a need arising in some way from the existence of mineral deposits. The prospector, with his crude tools, blankets, and simple food packed upon his faithful burro, goes ahead. In his business neither roads nor trails are necessary or specially desirable. He finds the mineral; the news gets abroad, and others flock in to try their luck in the newly explored region. Then comes the trader with supplies, men to buy, and miners to work the new finds. The freighter with his mule teams furnishes transportation, and for his use are built the first mountain roads. The motto is, "Get there and get there quickly." The first desideratum seems to be a route over which vehicles on four wheels can travel without tipping over. It is often so steep in places that wagons can only be pulled up with blocks and tackle, and descend with wheels rough locked and dragging a heavy log behind.

Next come roads to particular mines, toll roads, county and State roads, each case usually affording ample latitude and scope to the actual ignorance or bad judgment of men of all grades of supposed road cunning. There is not a mining county or a mountain county (the terms may be considered synonymous) from the eastern base of the Rocky Mountains to the Pacific coast where the money squandered in traveling over bad roads would not in five years build new ones intelligently located and properly constructed.

But the saving to existing enterprises would be only a small part of the advantage to accrue to any region from such a betterment of its road system. The expansion of the mining industry everywhere is due principally to the development of ore bodies of low grade but abundant quantity, where processes involving the strictest economy and most careful saving at every step yield in the aggregate a slight margin of profit. Hundreds of thousands of tons of ore are mined and treated where this margin is less than $1 a ton. The saving of a few cents a ton on ore down to the mills and a corresponding saving in freight charges on fuel, lumber, provisions, and other supplies up to the mines means in the freight item alone a very considerable percentage on a large capital to companies producing hundreds of tons a day.

Throughout this great region thousands of deposits now lie idle, which, with roads properly constructed, will become available, furnishing a new, vast market for labor, mining machinery, and farm products, and benefiting directly or indirectly every industrial and financial enterprise in the United States. (Pl. XVIII, fig. 1.)

But mountain roads must not be considered alone from industrial or utilitarian standpoints. The inspiring, health-giving effects of mountain air and mountain scenery are universally conceded. For those living in them, and for those who come to them for business, pleasure, or health, the need for roads which can be traveled in safety and comfort is just as imperative as it is elsewhere. In all the older-settled regions of the country the sentiment which demands good roads is increasing with marvelous rapidity. This should not and will not halt at the foot of the mountains.

The conclusions as to practice presented in this paper, formed by the writer during twenty-five years largely spent in building and operating mountain roads, have been modified or confirmed by much conference with men of large experience and well-digested views on the subject. They are offered in the modest hope that in the criticism which may be elicited, the records of experience which may be presented by others, and the careful study of the subject which is now going on better methods in mountain road building will result.

The suggestions are intended to meet the conditions existing in Western mountain counties, where population and means are usually quite limited. They relate to a standard for road building which, while not elaborate or expensive, is certainly attainable and would be far in advance of prevailing average practice.

## GRADE, THE KEY TO CORRECT METHODS.

The key to all correct methods of mountain road building is grade. It is generally expressed by percentage. A 1 per cent grade means a rise of 1 foot for each 100 feet of horizontal distance traveled. There are 5,280 feet in a mile. Hence, a 1 per cent grade means a rise of 52.8 feet in that distance, a 2 per cent grade a rise of 105.6 feet, and a 10 per cent grade a rise of 528 feet.

The proper grade in each case must be determined by the conditions and requirements. For bicycle travel a 2 per cent grade can be ascended with comparative ease and descended with little effort. Heavier grades, up to 5 per cent, are practicable for this purpose when unavoidable. They can be ascended by the average bicycle rider without extremely arduous effort and descended without serious danger. Grades above 5 per cent are too steep for ascent with comfort or descent with assured safety.

For pleasure driving the grade, where practicable, should not exceed 4 per cent. A good horse with a light buggy and two persons will trot easily up a 4 per cent grade and as easily down without a brake.

With a higher gradient the strain in either direction becomes increasingly apparent.

For freight traffic the maximum grade admissible is 12 per cent. Four animals, together with the one or two wagons used on a mountain road, are all that one driver can safely and properly handle on steep grades. When he uses two wagons, lead and trail, at every stop ascending he must hold both wagons by the brakes on the lead. In descending with heavy loads, excepting when the roads are icy, he must control his wagons with brakes on both—the lead by the lever beside his seat, the trail by a strap leading to the brake lever. When the road is icy he must control the descent by rough locking one or more of his rear wheels. To rough lock, he attaches some rough device, like a piece of chain, or a short steel runner, grooved on the upper side to fit the tire and with projecting prongs on the lower, to the felly of a rear wheel, just in front of the point where it rests upon the ground. A chain attached firmly to the center of the forward axle is then tightly fastened to this rough lock. Thus secured, as the wagon descends the hill, the wheel remains rigid and the rough lock plows into the surface of the road.

Experience in heavy freighting has shown that wagons can be actually and satisfactorily controlled in all weathers on 12 per cent grades, but that they can not be thus controlled on steeper grades, and that where much heavy freighting has been attempted on steeper grades it has almost invariably been attended with terrible accidents. In freighting on any grade the weight and number of wagons will depend upon the proportion between material to be hauled up and freight back. On a properly constructed dry road four animals, averaging 1,300 pounds each in weight, will haul 6,500 pounds, total weight, distributed between wagons and contents, up a 12 per cent grade at the rate of about 1½ miles per hour. Descending, the four animals will haul all that a wagon can hold up, but in practice this amount rarely exceeds 16,000 pounds on a single wagon or 20,000 pounds on a lead and trail, and the average is probably not much in excess of 10,000 pounds on one wagon or 14,000 pounds on lead and trail. When roads are icy heavy wagons tear up a roadbed badly.

But while a 12 per cent grade is admissible as a maximum, roads of lighter grade are so much more efficient and satisfactory in every way that only the gravest necessity should ever determine the maximum at 12 per cent.

Mountain roads are routes of travel between points of different altitudes. The most common, as well as the most serious, mistake made in their location is the attempt to cover this distance by too short a line. On a 12 per cent grade every pound of freight going up is elevated 12 feet for each 100 feet of horizontal distance traveled. On an 8 per cent grade it is elevated 12 feet in 150 feet of horizontal distance traveled, while on a 6 per cent grade it is elevated the same amount in 200 feet of horizontal distance; or, in other words, the distance required to get a 12 per cent grade must be increased one-half for an 8 per cent grade and doubled for a 6 per cent grade. Tables have been published giving the comparative weights which a horse can pull on different gradients; but, so far as the writer knows, no actual statistics have ever been compiled which show what would be the difference in performance in actual freighting between good roads of different gradients. The limit of load which a team can pull on any road is determined by the steepest place in that road. It is rare that a mountain road is built on which the maximum gradient is less than 12 per cent. It is also true that there are very few places where mountain roads have been constructed that it was not feasible to secure a maximum under 12 per cent. The extra length that would be required is generally much less than one would at first suppose. Roads built on a continuous uniform grade are very rare. Many seem to go up steep places just for the sake of going down again, thus giving a grade adverse to the heaviest traffic, which ought never to be compelled to climb a foot in descending a mountain. So far as the writer's study and observation have extended, 99 per cent of all roads built for heavy mountain traffic might have had a maximum under 12 per cent. It is putting it very moderately to say that a team will haul up 50 per cent more load in the same time between two given points on a road with an 8 per cent maximum than it could haul on one of similar surface with a 12 per cent maximum.

Besides the advantage in upfreighting, the 8 per cent road possesses many favorable points which are liable to be lost sight of. It is vastly safer for both light driving and freighting; on passenger vehicles brakes, while desirable, are not essential to safety; with heavy loads, if the brake fails, there is a fair chance of escape for driver, team, and wagon. Such a road is not seriously damaged by rain and melting snows, which work much injury on steeper grades; damage from rough locking is enormously reduced, and as such practice can be to a great extent avoided the time thus consumed is saved. Repair bills on wagons and harness are lessened, and the life of wagons is greatly prolonged. It is a pleasure to drive down an 8 per cent grade, as it produces a sense of exhilaration which most people find agreeable. As gradients become steeper the sense of danger grows more and more keen. The writer believes that 8 per cent is the gradient to be aimed at where important differences in elevation are to be overcome, and that such gradient can generally be secured. As a rule, in such cases a lower gradient means too long a route without commensurate advantage, while a higher means an unnecessary loss in the very purpose for which a road is required. The maximum adopted in the old Government pike crossing the Alleghenies was 7 per cent.

FIG. 1.—MARSHALL BASIN ROAD, COLORADO.

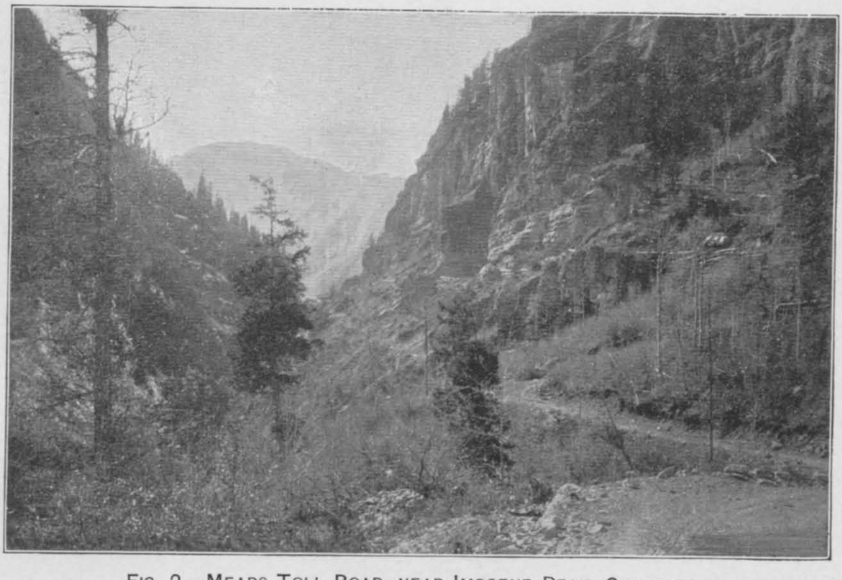


FIG. 2.—MEARS TOLL ROAD, NEAR IMOGENE PEAK, COLORADO.

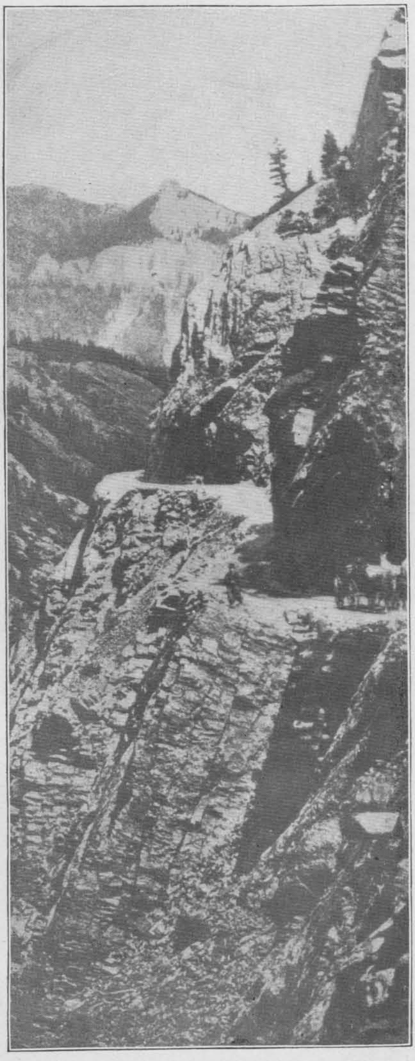


FIG. 1.—OURAY AND SILVERTON TOLL ROAD, COLORADO.

FIG. 2.—UTE PASS, COLORADO.

### IMPORTANCE OF LOCATION.

Next in importance to grade is location. The worst obstacle encountered on mountain roads is snow. The snow slide, or avalanche, comes sweeping down the mountain side, carrying along everything it meets and depositing its accumulations when the momentum is exhausted. The customary routes of these slides are generally quite apparent to the practiced eye of the mountaineer. In laying out a mountain road, one can sometimes avoid a snow-slide track by crossing to the farther side of the gulch. Sometimes it is possible to put the line so high that the snow slide will always stop beneath it. If a snow slide covers a road it is rarely practicable to clear it for heavy traffic for months. The accumulation of ice, snow, rocks, trees, and débris of all kinds is so enormous, and the cost of removing it during the cold, short days of winter so excessive, that a snow slide generally remains where it falls until nature lends the chief aid in its removal. In roads designed for heavy traffic, it is the wisest economy to avoid snow slides at almost any cost.

Next to snow slides in obstructive effect are snowdrifts, due to air currents. These act with remarkable uniformity from year to year. The places where these drifts accumulate in excessive amount can generally be located and avoided by careful attention. Deep ravines almost always catch snow. In a snow region it always pays to go around a point by a sidehill grade in preference to cutting through it.

The track of a waterspout must be carefully noted and an ample waterway provided. These result from currents of air due to physical outlines, and generally recur in the same places. They always leave abundant evidence by which their courses may be located.

Always locate roads on slopes facing south and east in preference to slopes facing north and west. These afford the sun greater power to settle and melt the snow.

A sidehill gives a better road than a creek bottom. (Pl. XIX, fig. 2.) It is always better drained and generally has a more solid foundation.

The matter of crossing streams should receive the most careful study. Bridges are costly to build and expensive to maintain. The writer recalls a mountain road that originally crossed the same stream sixteen times in the first 2 miles. This number has been reduced from time to time until now only two crossings remain.

Very steep sidehill slopes and hard rock increase the cost of road building. It is often possible by study to avoid them to a greater or less extent. It was a favorite expression with a very successful man that "Nothing pays like first cost in road building," meaning that money expended in intelligent study of a location was the most economical item of all the cost. Most problems in road location that at first seem impossible of practicable solution can be solved. Thousands of miles of mountain railroad have been replaced at enormous cost because of mistakes in original location, which more intelligent study would have avoided. The same principle applies in road building.

## OBJECT OF DRAINAGE.

In level regions we drain roads to protect their foundations; in the mountains we drain them principally to protect the surface. Water naturally runs off from a slope, and in doing so it must always leave more or less effect Every mountain road must run through a valley or along a hillside. If in a valley, the surface should have a crown of at least 6 inches, with gutters and ditches and drains just as in properly constructed roads in a level region. In mountain roads on hillsides, on the other hand, a very different practice must be adopted. The outside of the road must be the highest, with the view of conducting the water as quickly as possible toward the inside bank, where it should find a gutter to carry it to the nearest drain. This prevents the water from spilling over and washing away the outside bank, and also has a tendency to keep it from running down in the ruts and enlarging them. There is a vital reason for keeping the outside of the road on hillside grades higher than the inside. There is always a tendency for the wheels of a heavily loaded wagon to slew toward the lower side. This becomes very serious when the road surface is slippery, and terrible accidents have resulted. Rain or melting snow always wears down some of the material from the inside bank. If the road surface slopes outward, this débris follows the drainage across the road, continually increasing the slope, sometimes very rapidly in cold weather; hence, the roadbed, for the protection both of the bed and the traffic, should be constructed and maintained with an inward slope of at least one-half inch to the foot. The inside gutter should empty into drains crossing the roadbed diagonally at suitable intervals, determined by the amount of drainage.

## NECESSITY FOR PROPER BATTER.[1]

The importance of batter in mountain road building seems to be little understood, and correct practice is almost universally ignored. It is very common to see hillside grades constructed as follows: Insecure cribbing with a vertical face, constituting the outside of the roadbed; the inside bank cut as nearly vertical as possible, and three-quarters of the entire width of the road perhaps built of material filled in, the filling generally including all the trash available (boughs, sticks, boulders, etc.), with a covering of such material as the bank affords; width, in such cases, barely sufficient to hold a wagon when the road

[1] The side slope of a cut, embankment, or wall.

is first built. The destructive forces of nature act vigorously on such a roadbed from the start. Ice and water rapidly wear down the inside bank, and the débris falls upon the roadbed. The trash foundation settles and the road sinks, sloping outward. Water finds its way through this loose material and undermines the roadbed, making holes, or invisible death traps. The cribbing settles, rots, and soon disappears altogether. Unless such a road is practically rebuilt in a few years it grows more and more dangerous, and finally becomes absolutely impassable. The above is no fanciful sketch, but an accurate description of practices and conditions to be found almost everywhere in mountain regions.

Cribbing (Pl. XIX, fig. 1) is temporary in character, its use costly, and always to be avoided wherever practicable; when indispensable, it should have a batter not steeper than one horizontal to four vertical. Roads excavated in solid rock should have an inside batter of one horizontal to four vertical. This affords some latitude for projecting loads, which might otherwise be crowded off the road.

Roads excavated in plowing or picking ground should have a batter of one horizontal to one vertical—in other words, the inside bank should have a 45-degree slope; where steeper, there is too great injury from ice and water. This batter can always be secured without excessive cost. On sidehill grades made for wagon roads an outside bank made of loose material can generally be depended on to stand permanently at an angle of 40 degrees with the horizon. If made of rock, it will sometimes stand at a steeper angle and sometimes not, depending upon the tendency of the rock to disintegrate, so that it is best to adopt a 40-degree slope as a basis for estimates. Dry-stone retaining walls should be used only where indispensable, and should never be steeper than one horizontal to two vertical.

### WIDTH.

Cost, amount of traffic, safety, and comfort are the factors which must determine the width of a wagon road. Comfort and convenience are of course promoted by a double track. Extensive traffic demands it. Safety requires so much of it that teams can pass and never be caught unawares on a single track.

The proper width for double track and heavy teams is 16 feet, while it is possible for them to pass with extra caution on a 14-foot track on a straight road.

For single track and greatest safety a desirable width is 12 feet, while 10 feet is generally safe, and an 8-foot roadbed can be driven over if the inside bank has sufficient batter, so that vehicles will not be crowded off.

Double tracks for turnouts should never be less than 75 feet long. These should be visible from each other and from every foot of the intervening distance. Before laying out a road, the maximum distance between turnouts should be determined from all the conditions, especial consideration being given to the amount of travel likely to occur at night, and this maximum should never be exceeded. Where the conditions make it imperative to establish this maximum at over 100 feet for turnouts adapted to heavy traffic, it is well to widen the road for short distances at intervening intervals for light vehicles. A width of 12 feet will allow light vehicles to pass each other in emergency. Where the utmost economy must be observed, this extra width for a short turnout can be secured by cutting into the bank previously constructed with proper batter. Of course, it makes the inside bank too steep at these places, but it is a choice of evils in the interest of greater convenience and safety to light traffic. (Pl. XX, fig. 1.)

It is obvious that in sidehill grades excavated in picking or plowing ground, that portion of the road that is formed from the original material in place must for a time be more solid than the portion built out. It is consequently desirable on roads designed for very heavy traffic that all the wheels of heavily loaded wagons should rest upon the original solid formation. Standard vehicles are either 4 feet 6 inches or 5 feet between the centers of the tires. A very heavily loaded wagon can not be restricted to the same width of roadbed as light vehicles, but should be allowed a latitude of 8 feet for varying conditions of draft, road surface, etc.

A hillside composed of picking or plowing ground is rarely ever steeper than 35 degrees. A hillside grade formed by cutting 8 feet into such material makes an excellent road. The inside 8 feet of it is solid from the first and adapted to the heaviest traffic, and the balance, made by the fill, is sufficiently wide to allow lighter wagons to pass. The following table shows the total width of such a roadbed for various sidehill slopes and the amount of material which must be excavated for each 100 feet of roadbed:

*Widths of roadbed for various sidehill slopes, with amount of material excavated per 100 feet.*

EIGHT-FOOT CUT INTO PLOWING OR PICKING GROUND.

| Sidehill slope. | Width made by fill. | Total width. | Excavation per 100 feet. |
|---|---|---|---|
| *Degrees.* | *Feet.* | *Feet.* | *Cubic yds.* |
| 5 | 7.89 | 15.89 | 11.26 |
| 10 | 7.83 | 15.83 | 25.33 |
| 15 | 7.72 | 15.72 | 43.41 |
| 20 | 7.52 | 15.52 | 67.41 |
| 25 | 7.29 | 15.29 | 103.41 |
| 30 | 6.87 | 14.87 | 161.78 |
| 35 | 5.94 | 13.94 | 276.59 |

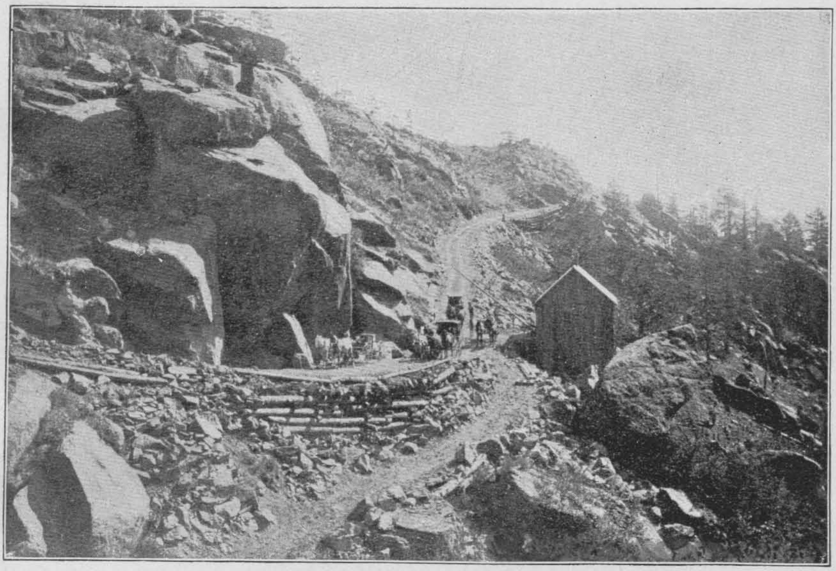


FIG. 1.—TOLLGATE ON PIKES PEAK ROAD, COLORADO.

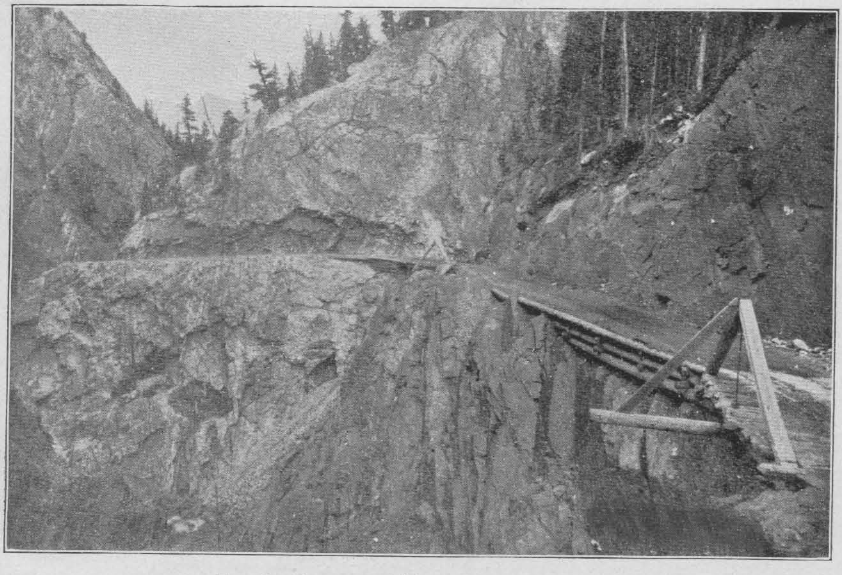
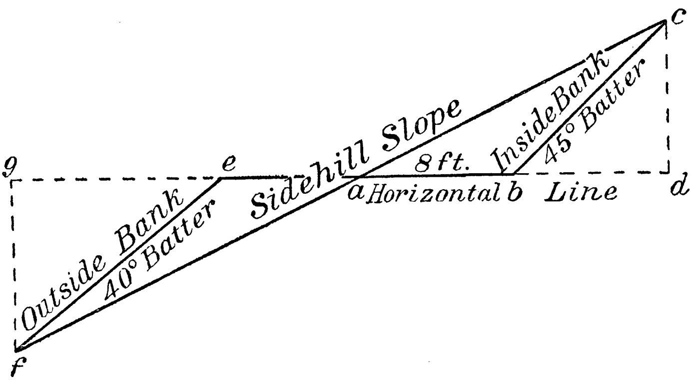


FIG. 2.—SILVERTON TOLL ROAD, COLORADO.

The following diagram and mathematical discussion are given to show the method by which the results presented in the table on page 190 were obtained:

*Diagram and equation for obtaining results in preceding table.*




$A = cad =$ sidehill slope.

$x = bd = cd =$ vertical depth of cut.

$1 : \tan A :: 8+x : x. \qquad x = \dfrac{8 \tan A}{1-\tan A}$

$z = ea =$ width of road made by fill.

$z + 8$ ft. $=$ total width of road.

$y = gf =$ vertical depth of fill.

$yz = 8x. \qquad z = \dfrac{8x}{y}$

$z = y\,[\tan (90° - A) - \tan 50°].$

$8x = y^2[\tan (90° - A) - \tan 50°].$

$$y = \sqrt{\frac{8x}{\tan (90° - A) - \tan 50°}}.$$

$$z = [\tan (90° - A) - \tan 50°]\sqrt{\frac{8x}{\tan (90° - A) - \tan 50°}}.$$

$$z = \sqrt{8x\,[\tan (90° - A) - \tan 50°]}.$$

In the above the inside bank is calculated with a batter of 45 degrees (one to one) and the outside with a batter of 40 degrees. The results of any other depth of cut may be quickly obtained from the table by simple proportion. For instance, for a cut of 7 feet into the bank the total width of roadbed would be seven-eighths of the figures in the table; for a cut of 9 feet the total width would be nine-eighths; for a cut of 10 feet, ten-eighths, etc.

Applying this to a 25-degree slope, we find that a 10-foot cut into the bank gives a total width of 19.11; a cut of 9 feet gives 17.20; one of 7 feet, 13.38; one of 6 feet, 11.47, and one of 4 feet, 7.64.

Amounts of material which must be excavated increase or decrease as the squares of the depth. To illustrate: For a cut of 7 feet the amount of excavation would be $\frac{49}{64}$ of the amount given in the table; for a cut of 6 feet, $\frac{36}{64}$; for a cut of 5 feet, $\frac{25}{64}$, and for a cut of 4 feet, $\frac{16}{64}$.

The following tables show the total widths of roadbed and amounts of excavation for a cut of 6 feet and for a cut of 5 feet:

*Total widths of roadbed and amounts of excavation for cuts of 6 feet and 5 feet.*

SIX-FOOT CUT INTO PLOWING OR PICKING GROUND.

| Sidehill slope. | Total width. | Excavation per 100 feet. |
|---|---|---|
| *Degrees.* | *Feet.* | *Cubic yds.* |
| 5 | 11.92 | 6.33 |
| 10 | 11.87 | 14.25 |
| 15 | 11.79 | 24.41 |
| 20 | 11.64 | 37.89 |
| 25 | 11.47 | 58.15 |
| 30 | 11.15 | 91 |
| 35 | 10.45 | 155.59 |

FIVE-FOOT CUT INTO PLOWING OR PICKING GROUND.

| Sidehill slope. | Total width. | Excavation per 100 feet. |
|---|---|---|
| *Degrees.* | *Feet.* | *Cubic yds.* |
| 5 | 9.93 | 4.40 |
| 10 | 9.89 | 9.97 |
| 15 | 9.83 | 16.96 |
| 20 | 9.70 | 26.33 |
| 25 | 9.56 | 40.41 |
| 30 | 9.30 | 63.19 |
| 35 | 8.71 | 108.06 |

In the above tables no account is taken of either increase or shrinkage in bulk of such material. On shallow fills of this nature the first effect would be a slight increase in bulk, which would tend to make the road a trifle wider, but the ultimate result would be practically what the figures in the tables indicate. That tendency always acting for the outside of the road to become lower and the inside higher must be overcome by repairs. We see from the tables that while we should cut 8 feet into the bank for a double-track road a cut of 5 feet will give a practical single-track road with only $\frac{25}{64}$ as much excavation, or that the double-track road requires more than two and one-half times as much excavation as a single track.

In sidehill grades in rock the conditions are very different. Rock excavations are made by blasting, which throws a large proportion of the rock down the hill, and consequently the material thus broken out can not be depended on with any certainty for fill. That which does remain available increases in bulk about 50 per cent.

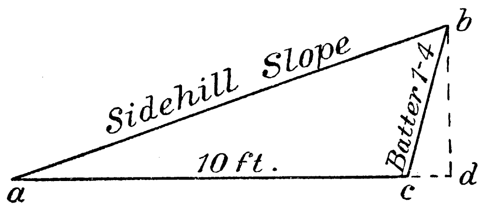
On rock slopes up to 20 degrees, unless very smooth and slippery, a fill will stand, the natural friction of the surface being sufficient to hold it firmly. Above 20 degrees this can not be relied upon, and any rock fills made on such slopes must be very carefully secured at the bottom to prevent sliding.

As stated above, while a bank made of broken rock will often stand with a steeper batter, it is not safe to figure on more than 40 degrees.

When the natural surface of the rock is too steep to hold a fill it is often the better practice to cut the entire roadbed out of the solid rock. A roadbed on a solid rock shelf is absolutely secure and in no danger of giving way without warning, because cribbing becomes rotten or retaining walls fail. Such a roadbed for single track should be 10 feet wide, carefully protected on the outside by a guard log not less than a foot in diameter at the small end, firmly bolted to the rock. The amount of excavation in solid rock on different hillside slopes to obtain such a roadbed is shown in the following table, accompanied by diagram and mathematical discussion illustrating how the results were obtained:

*Amount of excavation in 10-foot cut into solid rock.*

| Sidehill slope. | Excavation per 100 feet. |
|---|---|
| *Degrees.* | *Cubic yds.* |
| 5 | 16.30 |
| 10 | 34.07 |
| 15 | 53.33 |
| 20 | 74.07 |
| 25 | 97.78 |
| 30 | 125.19 |
| 35 | 157.04 |
| 40 | 196.30 |




$A = bad$ = sidehill slope.
$x = cd$ = horizontal depth of cut.
$4x = bd$ = vertical depth of cut.
$1 : \tan A :: 10 + x : 4x.$
$4x = x \tan A + 10 \tan A.$
$x = \dfrac{10 \tan A.}{4 - \tan A.}$

The above table can be used for deeper cuts by remembering that the amount of material varies as the square of the depth of the cut. For instance, an 11-foot cut will require $\frac{121}{100}$ the excavation shown in the table; a 12-foot cut, $\frac{144}{100}$, etc.

A preliminary survey of a contemplated line with some simple clinometer, determining the sidehill slopes for each 100 feet, and noting whether in solid rock or otherwise, will furnish the basis for an approximate estimate of the cutting, which is always by far the largest item of cost in a mountain road.

### THE BEST PRACTICE IN CURVES.

The minimum curve allowable on mountain roads has the arc of a circle with a 30-foot radius for its outer edge. All sharp curves and their approaches from each direction should be level. This principle, of such great importance to the efficiency of mountain roads, is generally either not understood or ignored. A moment's reflection will convince anyone that safety demands it, and that on such sharp curves a four-horse or six-horse team, to pull its maximum load, must not have any impediment from grade, as the wheel horses do most of the pulling.

All curves on steep grades should be equated (the grade lightened) and the roadbed widened. No universal rule for this can be laid down, but the best practice demands it and good judgment in locating always considers it.

Where a road winds backward and forward up a hill in approximately parallel lines the turns are called switchbacks. They are expensive and very undesirable. Where possible, they should be avoided, but when indispensable they come under the rule above laid down for minimum curvature and freedom from grade.

Wherever a bridge is approached by a curve its end should be flaring and the roadbed made wide and level. Curved approaches to bridges are of course very undesirable, and should be avoided if practicable.

### STAKING OUT THE ROAD LINE.

Staking out the road line must be done by a surveyor with a transit and target rod, set each time at the height of the instrument (horizontal axis of telescope). All grades can be determined with sufficient accuracy for wagon roads by angles of elevation from the horizontal. These angles are obtained from any table of tangents. An angle of elevation of 1 degree and 9 minutes gives a 2 per cent slope; an angle of 2 degrees 52 minutes a 5 per cent slope; an angle of 4 degrees 35 minutes an 8 per cent slope; an angle of 5 degrees 43 minutes a 10 per cent slope, and an angle of 6 degrees 51 minutes a 12 per cent slope. An Abney level (also called a pocket altimeter) is a very valuable instrument in laying out a road line. With it one can make a preliminary reconnoissance without being burdened with a transit.

On sidehill grades we stake the outside of the cut at grade. Slope stakes must be set to determine where the inside line of the cut begins. These can be set with sufficient accuracy with a 12-foot straightedge, a clinometer, and a tapeline. An Abney level and a tapeline are better still. The surveyor can make himself a little table, which will show the distance from his eye to the foot of the slope stake for each five minutes difference in elevation registered by his Abney level for the various widths of cut to be used—one table for rock cuts and one for picking or plowing ground.

### DETAILS OF CONSTRUCTION.

In constructing mountain roads a sidehill plow with reversible share is a sine qua non. The writer has seen six strong mules and four men working hard to run a furrow uphill, when two animals, attached tandem to a sidehill plow, and two men could have done more work and with much greater ease. It is surprising how rapidly a sidehill grade can be constructed with such a plow and a scraper. When the two lines of stakes are in (grade and slope stakes), you start right and you come out right. Your inside bank has the right batter and your road the full width you meant it should have. It is very common to see a contractor on a mountain road, who attempts to grade without slope stakes, find his roadbed too narrow. It is too late for him to use his plow, and he must widen out with pick and shovel, the last operation costing perhaps as much as the entire grading should have cost if done rightly from the start. (Pl. XX, fig. 2.)

SLIDE ROCK.

In the mountains we often find the hillside slopes covered with broken stone of various sizes. This we call slide rock. This slide rock may be very coarse and the surface extremely ragged, when it is called "heavy slide." It may be fine and bound together by soil, in which case it can be plowed. It may be fine and dry and run just like dry sand when one attempts to walk on it or otherwise disturb it; this is called "fine slide rock." To construct a road in coarse slide we build a retaining wall on the outside of the grade of large rocks weighing not less than 75 pounds each. We then shape our roadbed, making it as smooth as possible with the material at hand, and cover this surface with fine slide. All rock retaining walls for mountain roads when laid up dry should have a batter of one horizontal to two vertical. They should only be used where the filling behind them is coarse rock. If used to hold loose material with a batter of one to two, they may be gradually crowded out and the bank give away. If made less steep than one horizontal to two vertical to hold loose material, the method is too expensive to be ordinarily practicable. Coarse and rough and discouraging as heavy slide may look, the very best results may be obtained in it if the entire process is accomplished carefully and conscientiously. It furnishes an absolutely solid, perfectly drained road foundation, is unaffected by the elements, and requires less outlay for repairs than any other variety of mountain road.

Probably the most perplexing material which the inexperienced road builder encounters in building a road is fine slide rock. It appears to be so utterly unstable in every way that he does not know how to attack it, and it seems impossible to obtain either definite or satisfactory results. He can not plow or scrape it. Neither he nor his animals can keep their footing in it. Fortunately, patches of slide rock are never very long, and while the process of making a road across it is tedious and somewhat expensive, it can always be successfully accomplished.

The following instructions carefully observed will always yield satisfactory and gratifying results:

Stake out the grade line, setting the stakes about 25 feet apart and driving them down as firmly as possible. They will stay in place for a time if put in deeply enough. Slope stakes in fine slide rock are useless. As it always stands at about the same slope (35 degrees), the process is very uniform.

For a single track, put up another row of stakes vertically 7 feet below the grade stakes; for a double track, 10 feet vertically below. These lower stakes determine the foot of the cribbing which must hold the road. It is thus constructed: The logs should never be less than 10 inches in diameter at the small end, and the larger the better. The crosspieces should be uniformly 8 inches in diameter. That kind of available wood should be selected which experience has shown will rot most slowly, and all bark must be carefully removed. The logs need not be of any definite length, but the courses should always break joints. Now, beginning at the lower row of stakes with pick and shovel, make a bench, and on its outside edge carefully bed the bottom log. Then dig into the bank and bed each crosspiece. These should be 5 feet apart from center to center, with cross notches to fit triangular edges in the logs, just as house logs are fitted together. This notching should be done with much care to permit the logs to just touch, so that the crosspieces may be weakened as little as possible. The proper length for these crosspieces is 8 feet. They should never be bedded level, but always with a downward slope into the bank. With time and patience the lower row can be properly bedded and a good foundation for the cribbing secured. A dozen pointed inch steel bars driven in a row 3 inches apart, sloping into the bank, will help materially to hold back the slide while digging to bed crosspieces. Proceed to build up the cribbing, filling in with slide as the work progresses, remembering that the batter of the structure should be one to four.

When grade line is reached, there will be a 10-foot roadbed for single track and 16 for double track, fairly solid on the start and rapidly compacting with travel. Consolidation will be effected by a light dressing of some fine clayey material, if accessible, but this is not indispensable. Every road across fine slide must have careful attention. For all time fine slide will run down onto the roadbed, and it must be shoveled out occasionally, but this will not be a serious item of cost; in other ways the roadbed will be very satisfactory. It has natural drainage, the best of material is always at hand to fill ruts and chuck holes, and a hard, even surface can be maintained. The road grows a little wider each year. Cribbing thus constructed will last many years, and when it does finally give out, it will be found that a substantial foundation for the new road can be obtained without going nearly as deep as at first.

### CORDUROY.

In laying out mountain roads we often encounter a spongy soil filled with water, especially above timber line. This almost invariably proves to be shallow with a substratum of good road material. This surface soil must be removed and a system of drainage adopted to keep surface water from running onto the roadbed. Occasionally corduroy is economical to meet such conditions, but it is a very undesirable expedient, and should be adopted only in extreme cases.

As in cribbing, all corduroy material should be the most durable to be obtained and the bark removed. The stringers should be not less than 10 inches in diameter, 30 inches apart from center to center, carefully bedded to an approximate level, and their tops adjusted for uniform contact with the covering by the use of a long straightedge and adz. A row of 2-inch planking on each side, thoroughly secured by long spikes to each crosspiece, will prevent its rolling. If a crosspiece is occasionally bolted to its outside stringers, there will be no creeping. Lines should be carefully hewed for wheel and horse tracks. This is often overlooked, and corduroy then becomes an unbearable nuisance. Another mistake often made with corduroy is getting it too narrow. It ought never to be less than 12 feet wide for single track and 18 feet for double track.

A thorough system of both cross and longitudinal drainage must be adopted to protect the corduroy from quickly rotting and to keep its foundation from settling unevenly.

Rollers can rarely be used to advantage on ordinary mountain-road grades, which, if properly constructed, will soon pack hard under the wheels of heavy teams. If wide tires were required by law, roads would be protected, heavier loads could be hauled, and expenses of maintenance and operation much reduced.

### DRESSING.

All mountains are made of rock, the soil with which they are in places covered being merely a product of rock decomposition and water concentration. We can generally find a rock dressing prepared by nature within convenient distance of a mountain road. We sometimes find a complete material in one place and sometimes get better results by mixing two kinds. A hard rock in angular fragments makes an excellent road covering if we put some suitable fine material on top of it. Two inches is the maximum diameter allowable for any piece of road-covering material. Where the fragments are larger, it should be screened. Sometimes it is best to mix two kinds of rock, one hard and durable and the other disintegrating more rapidly through wear and chemical decomposition. Nothing ever takes the place of a rock covering for roads. It can always be cheaply obtained in a mountain country. If nature does not furnish a suitable preparation of it within economical distance, it can be cheaply prepared. Nearly any mountain county can secure a portable crushing outfit for not to exceed $500, and can find material to use it on within convenient hauling distance of any road.

Most mountain roads at first require dressing only in stretches, and later for repairing holes and ruts and for maintaining a suitable inward slope. A covering of 3 inches is ample for a beginning. Six hundred tons of rock dressing will completely cover a full mile of single-track road, and on the average mountain road that amount would be sufficient for 2 miles.

If a road surface is to wear evenly, it should be homogenous, that is, it should not be built or repaired in spots with different kinds of materials; a clay road should not be patched with gravel nor a gravel road with clay. Whenever holes or ruts occur these depressions should be filled with material of the same kind as constitutes the road surface. Detritus, resulting from traffic, which is washed by rains into the gutters, should not be placed back upon the surface, for it has lost its power of cementation; it should be thrown away and replaced by fresh material. No perishable material of any description, under ordinary circumstances, should be permitted upon the roadbed, sod being particularly objectionable.

# FUNGOUS DISEASES OF FOREST TREES.

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## INTRODUCTION.

In the Yearbook of the Department for 1896 the agencies which bring about disease and death of trees were described as (1) those in which conditions of soil and climate are the controlling factors, and (2) those where parasitic enemies, such as insects and fungi, are the principal agents involved. In the following pages some of the more important fungous diseases will be considered, with special reference to such as injure the wood of forest trees so as to make it unfit for lumber.

In any consideration of the life and growth of trees one must not forget that every tree, after it has reached a certain age, which varies with different trees, is composed of two distinct parts, the living part and what may for the sake of convenience be called the dead part. The former consists of the leaves, the younger branches, and the smaller roots, and of a thin layer, including the most recently formed wood and the inner bark, while the latter includes the old wood of the trunk, larger roots and branches, inclosed by the newer wood, and the bark. The living parts are renewed at short intervals, while the old wood, known as heartwood, becomes permeated with certain preservative and coloring materials, and serves mainly as a support for the growing parts of the tree. Fungi which cause disease may so affect the living parts that they cease to perform their functions, or they may destroy the dead parts so that they can no longer support the living wood and the leaves.

Fungi are a class of low plants, possessing no coloring matter, which consist of fine threads called hyphæ, many hyphæ forming the mycelium. The mycelium grows in or upon dead or living matter, from which it extracts certain food substances. After a sufficient quantity has been absorbed, provided that conditions are favorable, fruiting bodies are formed which develop the spores. The fruiting bodies of the larger fungi found on trees are generally known as sporophores. Of the fungi which attack forest trees, some flourish in the leaves and twigs, others in the wood of the trunk and branches. The leaf fungi are rarely present in sufficient number to kill a large tree, although they may stunt its growth. A number of fungi are very destructive to the younger twigs and to very young trees. As an instance, may be mentioned the large gall formed by a rust fungus (*Peridermium cerebrum*) on the main stem of young pines and on young branches, which at first stunts the tree and finally kills it. In eastern Oregon and Washington a large percentage of the 2-year-old seedlings of the Lodgepole Pine (*Pinus murrayana*) are killed by this fungus. The well-known cedar apples are caused by another rust fungus which lives in the tissues of the young Red Cedar branches.

Several fungi grow in the living tissues of the roots, where they bring about changes which ultimately result in the death of the tree. The honey mushroom (*Agaricus melleus*) is one of these. Its long strands grow between the bark and the wood, and in a short time after infection they kill the delicate bark and cambium cells. As a result, the trees die, but their wood is not injured. *Polyporus versicolor* is another fungus which kills the roots without injuring the wood.

## FUNGI WHICH DESTROY THE WOOD.

The fungi which are of particular interest to the lumberman and forester are those which render the wood valueless. Of these, there are a large number, some living in the wood of the roots, others in the wood of the trunk and branches. Some are confined to the dead heartwood, while others can grow in both heartwood and sapwood. The fungus threads penetrate the wood cells in all directions, and gradually destroy them. This weakens the roots or the trunk, and frequently results in the overthrow of the tree during some windstorm, or when the tops are laden with snow. In Pl. XXI, fig. 1, a large hemlock growing in the Cascade forest of Oregon is shown. The wood of the roots and the lower part of the trunk has been destroyed by a fungus, and during the past summer the tree, which was still alive, was overthrown. Such trees die rapidly, and the wood not yet destroyed by the first fungus is attacked by others, to be referred to later. The trunks of some trees are attacked in the tops, and in that case the trees may remain standing for many years with their heartwood completely decayed. The presence of such fungi is not generally detected until the trees are cut down. Lumbermen have, however, learned to recognize some of these trees to be diseased by various signs, such as the presence of resin accumulations (Pl. XXI, fig. 2), or of the fruiting bodies, called conchs, or punks.

## HOW TREES ARE INFECTED.

Plants in general have numerous natural means for protecting themselves against the attacks of fungi, such as the cutinized, or skin-like, surfaces of the leaf, the thick bark of the tree trunks, and the exudation of gums and resins, which close wounds against influences from without. During the early life of a tree these means are more effective than later on, when the vigor of the tree is reduced. Wherever a break is made in these natural barriers, insects and fungi are sure to enter. The two parts of the trunk, the living and dead parts, are attacked by different kinds of fungi, and when wounded they react in very different ways. Wounds made in the live parts are quickly covered with gum or resin, followed by their complete healing over by a layer which develops from the edges. In the tender parts of leaves and branches a cork layer frequently forms below the wounded areas, which makes the entrance of fungus spores and threads more difficult. Because of this rapid healing, one finds but few destructive fungi entering the live parts. The dead part, on the other hand—that is, the inner portion of the tree comprising the heartwood—has of itself no means of excluding the spores or filaments of fungi. Its sole protection lies in the living layer which surrounds it on all sides. When the latter is broken so as to expose the dead inner part for only a small space, the exudation of gum or resin from the living parts may suffice to protect the dead parts, particularly when the tree is young. In those trees which do not make gum or resin, a peculiar brown gum-like substance forms in the wood cells when exposed to the air, which is supposed to protect the exposed parts against fungus attack. Moreover, one finds that the heartwood of some trees is protected against these fungi, probably because of some peculiar chemical compounds which are contained in the wood cells. The wood of the Cypress (*Taxodium distichum*), Red Cedar (*Juniperus virginiana*), and Redwood (*Sequoia sempervirens*) is an example of this kind.

### HOW WOUNDS ARE FORMED.

In the primitive forest wounds are made in the trunks of trees by deer and other browsing animals, which eat the bark and newer wood. Bears are fond of pulling long strips of bark from the various cedars in order to get at the sugary sapwood.. Wounds of this kind heal rapidly, and when they give entrance to spores, these are usually of the parasitic kind that do but little harm. Birds, particularly woodpeckers, make large holes in living trees, which oftentimes give entrance to wood-destroying fungi. Boring insects make holes in the bark and wood of standing trees which result not only in the death of the tree, but hasten the entrance of fungus spores. The roots are injured by burrowing animals, particularly by moles. The wounds made by animals are insignificant, however, when compared with the wounds caused by the breaking of large branches. As a tree grows older the larger branches are composed of heartwood and sapwood, and when such a branch is broken off by the wind or the snow the heartwood is exposed. Many trees speedily cover the broken branch stub with a callous layer, but when the break occurs far out from the trunk this may never be accomplished. Pl. XXII, fig. 1, shows a section of the base of a Red Fir (*Pseudotsuga taxifolia*) branch which has been dead for some years.

The base of this branch is embedded in the heartwood, and it extends through the sapwood to the outside. A windstorm probably broke off the outer portion of the branch, leaving a stub several inches long, around the base of which a healing callus is forming slowly. It will be noted that at the present rate of growth of this callus it would take many years to cover this branch entirely. In the meantime the spores of fungi germinate on this stub; the hyphæ of the fungus grow into the dead wood of the branch and through it into the heartwood of the main trunk. While the tree is young the natural pruning which takes place in a dense stand causes many branches to break off, but these are generally small, and, furthermore, they break off close to the trunk because of the constant pressure of the callus at their bases.

Boring insects assist in making passageways for the fungus threads through layers which they could not cross. The old resin-infiltered branch stubs of coniferous trees are not penetrated by fungus threads. Many borers enter these dead branches, however, and pass down them into the trunk. They have just begun in the stub shown on Pl. XXII, fig. 1. The channels which they make admit water, and in the dejecta which they leave in these channels the spores of many of the fungi germinate.

## HOW TREES BECOME INFECTED.

Spores of the various wood-destroying fungi float about in the air and lodge in the cavities or irregularities of a dead branch, where they germinate. The fungus threads grow down through the dead heartwood of the branch, and ultimately reach the main trunk of the tree (Pl. XXIII, figs. 1 and 2). From the base of the branch the threads spread up and down through the trunk and bring about the changes to be described below. This manner of entrance can readily be noted in any forest. Pl. XXIII, figs. 1 and 2, shows a case of this kind. The larger branches of the Red Fir usually divide into groups of three or four at a short distance from the trunk. In this instance one of these branches had been broken off by the wind, and the spores of *Polyporus pinicola* have germinated in the stub, decaying the wood. Pl. XXIII, fig. 1, shows a section at a point on the main branch just below the union of the group of three. At the left the decayed branch is seen. Pl. XXIII, fig. 2, is a section of the main branch 1 foot toward the main trunk from the last section. It will be seen that the entire heartwood is decayed at this point.

The fungus threads have grown down through the dead branch into the heartwood of the living branch, on their way to the main trunk, which in this instance they have almost reached. The branch shown grew at a height of 175 feet from the ground. Another tree close by

FIG. 1.—WESTERN HEMLOCK, THE TRUNK OF WHICH WAS WEAKENED BY A ROOT FUNGUS. THE TREE WAS BLOWN OVER DURING THE PAST SUMMER.

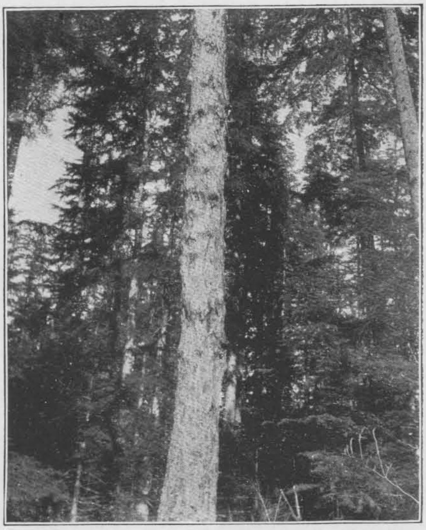

FIG. 2.—TRUNK OF WESTERN LARCH, SHOWING POINTS WHERE RESIN EXUDES FROM DISEASED WOOD.

FIG. 3.—BURNED AREA (FIRE OF TEN YEARS AGO), SHOWING TOTAL DESTRUCTION OF YELLOW PINE BY POLYPORUS PINICOLA.

FIG. 4.—POLYPORUS PINICOLA GROWING ON DEAD TRUNK OF WESTERN HEMLOCK.

FIG. 1.—DEAD BRANCH OF RED FIR, SHOWING ORIGIN OF BRANCH AND HOW HEALING IS BEGINNING.

FIG. 2.—THE FRUITING BODY OF TRAMETES PINI ON SUGAR PINE.

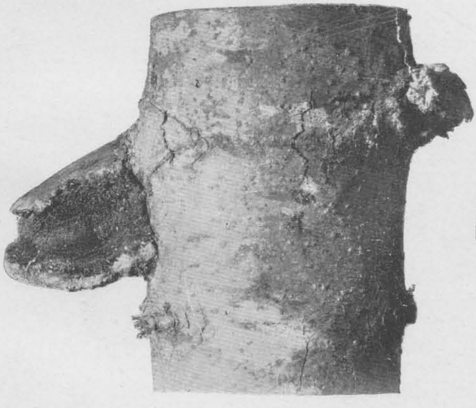

FIG. 3.—THE FRUITING BODY OF A WOOD-DESTROYING FUNGUS GROWING ON A LIVING FIR.

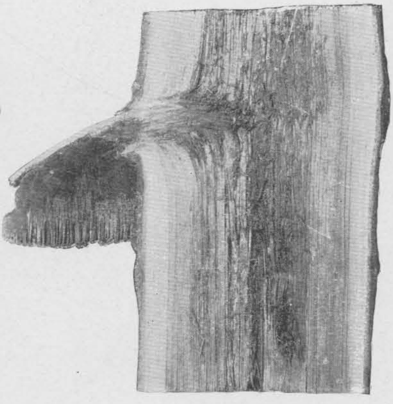

FIG. 4.—THE FRUITING BODY OF A WOOD-DESTROYING FUNGUS GROWING ON A LIVING FIR, SECTIONED TO SHOW HOW THE FUNGUS HAS DESTROYED THE WOOD AND HAS THEN GROWN OUT THROUGH A BRANCH.

FIG. 1.—RED FIR BRANCHES, SHOWING HOW DECAY IS PASSING DOWN A DEAD BRANCH.

FIG. 2.—SAME BRANCH 1 FOOT NEARER THE TRUNK, SHOWING HOW DECAY HAS EXTENDED INTO THE LIVE BRANCH AND HOW THE RESIN IS BEING DRIVEN INTO THE SOUND WOOD.

was similarly affected, but the decay had already gone some 20 feet up and down in the main trunk from the point of entrance.

That this method of infection is the most usual one for diseases which start in the tree tops, is made very evident in regions where tracts of forests are exposed to high winds, which break off the large branches. These tracts may be on the crests of hills or along the shores of streams or more often lakes, where the winds have a long, free sweep. One will find the percentage of diseased timber uniformly higher in such localities than in the more sheltered areas close by. The paths of violent windstorms can often be traced through a forest by the infected trees. A notable case of this kind was found on the northern slope of Mount Rainier, where a "streak" of punky timber, as the lumbermen call it, runs for several miles through the Red Fir forest.

Infection below the ground may take place through the large roots, or through the trunk at the lower end of its vertical axis. Many coniferous trees have a very shallow, flat root system. The base of the trunk is usually its weakest part, and it is found that many boring insects select this as the spot for entrance, notably the large ants which destroy so many firs and spruces. The openings thus made allow the threads of fungi like *Polyporus schweinitzii* to enter and grow up into the trunk and down into the roots. The form of decay caused by these root fungi is variously known as bottom or foot rot.

### AGE AT WHICH TREES ARE INFECTED.

Young trees have few wounds, and these heal rapidly. As the tree grows older the chances for infection become greater every year, and after a certain age has been reached one may say that almost all trees are diseased at some point, a fact well known to lumbermen. It will be of importance to determine what this age is for the different kinds of timber, for it is often possible to take this into account in the harvesting of a timber crop. When trees have reached this age they may be considered ripe, and the yearly growth and consequent increase in value will be overbalanced by the almost certain chances of destruction by one or another of the wood-destroying fungi.

### HOW THE FUNGI DESTROY THE HEARTWOOD.

The fungi are a low class of plants which require certain substances to sustain their growth, just as the higher green plants do. While the latter take comparatively little from the ground in the way of food, the fungi are entirely dependent upon their host plants. By means of certain complex chemical substances they are able to feed upon the plant on which they are growing, utilizing the contents of living cells, or their walls, or both. The wood-destroying fungi extract certain elements from the walls of the wood fibers, which give rise to complex chemical changes in these fibers, differing according to the fungus.

Some of them extract the substances which bind the individual fibers to one another, leaving them as separate shining white cellulose fibers (Pl. XXIV, fig. 1), while others extract the cellulose and leave a brittle brown mass resembling charcoal (Pl. XXIV, fig. 2). These changes may go on throughout the wood, or may be confined to local areas. The changes brought about by the fungi are popularly spoken of as rotting, and whatever their nature, they destroy the mechanical properties of the wood. When the decay is induced by fungi entering at the roots, it gradually spreads up the trunk, and in course of time the latter becomes weakened to such an extent that it breaks, usually at a point some 10 feet from the ground (Pl. XXI, fig. 1). The tree may be perfectly healthy and alive on the outside when it falls, but it dies rapidly after the fall, so in one sense the fungi destroying the heartwood may be said to kill the tree.

From the standpoint of the lumberman these fungi ruin the wood for commercial purposes, and the amount annually so destroyed can only be guessed at. Wood which is in the early stages of decay may be used as a low grade of lumber, and in some instances even rotted wood is used for such purposes as do not require great tensile strength, notably in the case of the pecky cypress and California Incense Cedar (*Libocedrus decurrens*).

While the fungus is at work within the tree a number of secondary changes are taking place, which often serve to reveal the presence of decay in trees. This is true particularly of the coniferous trees. One effect of the presence of hyphæ in the wood cells is to liquefy the resinous contents of the walls. The turpentine and resin pass on before the invading hyphæ, going up and down the trunk and outward into the living parts. This makes a darker ring around infected areas, which is well shown in Pl. XXIII, fig. 2. The turpentine is under considerable pressure, and seeks to escape wherever it can. Old branches not yet healed over offer outlets, and it is through these that the turpentine and resin flow, dripping down from the stubs at numerous points on the trunk (Pl. XXI, fig. 2). With the evaporation of the turpentine the resin remains as a solid mass, which increases from year to year, and prevents the healing of the wound, and ultimately causes the bark to diverge at an angle from the old branch, thus making a wide hole filled with resin. It is in these holes that the fruiting organs of the fungus frequently form.

These resin knots when first seen indicate that the tree is infected, and, if possible, it ought to be cut down, as a portion of the trunk will then be found useful, while if left it would soon entirely decay.

### RATE OF DECAY.

Very little is as yet known of the rate at which trees are destroyed by these fungi. Information obtained from timber cruisers seems to

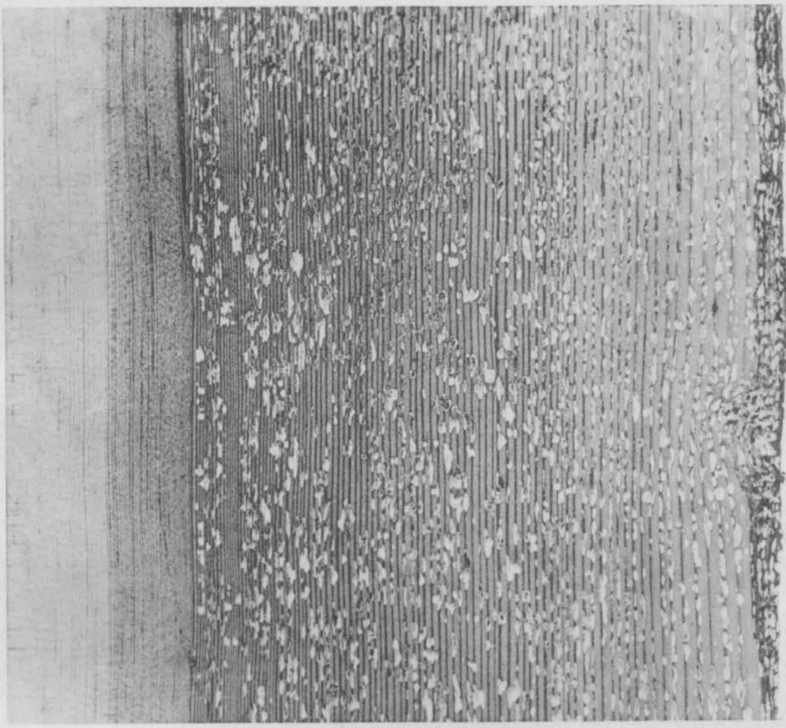

FIG. 1.—SPECKLED ROT OF RED FIR LOG CAUSED BY TRAMETES PINI.

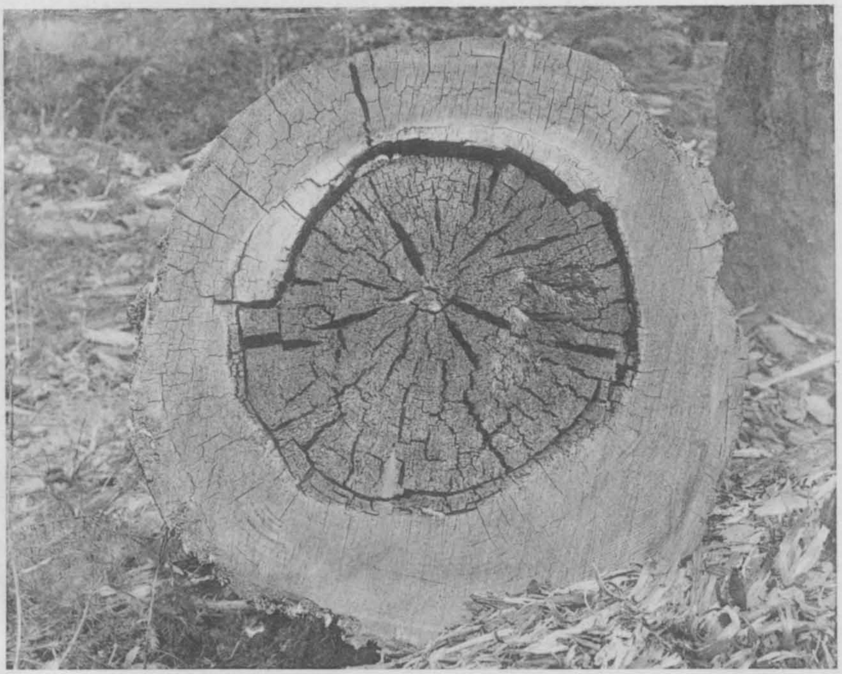

FIG. 2 – BROWN FOOT ROT OF RED FIR CAUSED BY POLYPORUS SCHWEINITZII.

indicate that the larger areas may be infected and rendered worthless within fifteen years. This is a problem which is yet to be solved, and obviously one of great importance to the lumberman and forester.

### FRUITING ORGANS.

After the vegetative filaments of the fungus have extracted a sufficient amount of nutritive material from the wood they grow outward to form the fruiting organ which is to produce the spores. These organs vary in form and in their mode of occurrence. Many of them are the well-known punks, or conchs, toadstools, or frogstools, found on the trunks (Pl. XXII, figs. 2 and 3, and Pl. XXI, fig. 4); others are more insignificant, growing as white or brown patches on the roots or just above the ground. When growing on the trunk the hyphæ may grow out through an old branch (Pl. XXII, fig. 4), or in cases where the sapwood is killed they may grow out at any point on the bark. Pl. XXII, fig. 3, shows a toothed form (*Echinodontium tinctorum*) growing on a Noble Fir (*Abies nobilis*). The mycelium has grown out through the branch (Pl. XXII, fig. 4) and has formed the hard fruiting organ on the outside. In the same plate, fig. 2, is shown a common form growing on the pines. The spores are formed on fine filaments in long tubes or on the spines and gills found on the lower surface of the fruiting body. When ripe they are discharged in clouds; they float off through the air and lodge in the crevices of the bark and in wounds. When one considers the countless thousands discharged by one sporophore every year it is not to be wondered at that the chances for infection are very great.

The fruiting bodies may be one or more years old. In those which grow to be more than one year old a new layer is added on below the old ones, and in this way a particular individual may grow to be fifteen or twenty years old. The number of fruiting bodies on a trunk varies. The fungus causing the white rot of the oak usually forms but one fruiting body; so also the one causing pin rot of the Incense Cedar (*Libocedrus*). The majority form many on one trunk, increasing in number from year to year.

Those fruiting bodies which grow on the ground discharge their spores downward onto the soil, and many germinate there and grow through the ground, spreading in that way from one tree to neighboring trees.

The decay started by the threads of the fungi stops almost immediately when the tree is cut down. In the majority of cases the fruiting bodies do not form on the trunk after the fall of the tree. Notable examples of this are the red-hearted wood of pine, caused by *Trametes pini* (Pl. XXIV, fig. 1), and the yellow-rotted wood of the Locust (*Robinia pseudacacia*) found in many of the Eastern States. The wood is completely destroyed as far as the decay extends while the trunk is standing, but growth of the fungus stops when the tree is cut, and lumber cut from partially decayed trees can be used for many purposes without fear that the process of decay will continue. Intimately connected with this fact is the comparative immunity of some classes of timber to fungi after cutting. Some are almost indestructible after they are cut, as, for example, the Locust and Cypress, but their wood is frequently decayed while the trees are alive.

### SOME DESTRUCTIVE FUNGI.

A number of the more destructive fungi may now be mentioned briefly:

TRAMETES PINI (Brot.) Fr.—Foremost among the timber-destroying fungi is the large brown "punk," or "conch," found in its typical development on the Longleaf and Shortleaf pines, *Pinus palustris* and *Pinus echinata*. (See Pl. XXII, fig. 2). The fruiting bodies form large masses which grow out from a knot hole, oftentimes as large as a child's head. They are cinnamon-brown on the lower surface and much fissured and broken on the black, charcoal-like upper surface. This fungus causes probably four-fifths of the destruction brought about by the timber-destroying fungi. It occurs on most of the conifers in the United States which have any value as lumber trees, and brings about a characteristic white spotting of the wood (Pl. XXIV, fig. 1), which varies with the kind of tree attacked. The wood at first turns dark red-brown, and trees in this stage are known to the lumberman as "red-hearted" timber. The color becomes somewhat lighter in the later stages, and white spots appear here and there in the wood. These gradually increase in number and in size, until the entire wood is full of small holes lined with a fine felt of white fibers. In some trees, notably the Eastern Tamarack (*Larix laricina*), the wood splits into annual layers; in others it becomes very soft and spongy, as in the various species of fir (*Abies* sp.). The harder woods have more holes in the spring wood, and some of the timber—for instance, that of the Red Fir (*Pseudotsuga*)—is characterized by the greater distance between the white areas. The wood never rots entirely, for there is always a mass of spongy wood left. The fungus enters through the large branches of the top in most cases. A rather striking exception is found in the Western White Pine (*Pinus monticola*), where it always enters at a point close to the ground. It is suggested that the heavy snow fall in the mountain regions may have something to do with this mode of infection. Recently affected trees show the dripping resin spoken of above.

POLYPORUS SCHWEINITZII.—This fungus is one which propagates through the soil and causes a brown rot of coniferous trees (Pl. XXIV, fig. 2), starting at the roots and growing up into the trunk to various heights. The wood turns light yellow at first, and gradually dries, so that numerous fissures appear throughout the mass. In many trees the roots give way, which causes the tree to fall; in others the trunk breaks off close to the ground before the fungus has had time to grow very far up within it. From one tree the fungus threads grow through the soil and infect neighboring trees, so that one will usually find many trees in a clump, all of which are affected with this fungus. It has been suggested that moles and mice are active in spreading it under ground. The fleshy, umbrella-shaped fruiting bodies of this fungus are found in July and August at the base of diseased trees. They are at first yellow at the margin and red in the center, but gradually turn dark brown. They discharge their spores in August and disappear soon after, as many insects devour the fleshy mass with avidity.

POLYPORUS SULFUREUS.—This fungus causes a brown rot of many coniferous trees, and also of oak, walnut, cherry, and other deciduous trees. It was described in the Yearbook of the Department for 1896 (p. 252).

POLYPORUS IGNIARIUS.—This is a conspicuous fungus frequently found on beeches, apple, oaks, etc., in the wood of which it flourishes and brings about a white soft rot. Usually several of the fruiting bodies occur on a single trunk. They are more or less hoof-shaped, and of a light cinnamon-brown color.

POLYPORUS NIGRICANS.—The birches, poplars, and beeches of the New England States are frequently destroyed by this fungus. It enters through wounds and grows rapidly in the heartwood of these trees. The decayed wood is soft and spongy, and has absolutely no tensile strength. On that account one finds many of these trees broken down in the forests after a windstorm.

POLYPORUS ANNOSUS.—This fungus, much feared by the European forester, is not very destructive in this country. It has been found on many of the pines, where it brings about a red rot of the root system, which ultimately results in the death of an affected tree. The fruiting bodies form as small cup-shaped or irregular masses on the roots or around the base of the trunk. It has also been found growing on dead trees, many years after they had died. Neighboring trees generally become infected from a diseased tree, as the mycelium readily grows into the small fibrous roots, and from there into the larger roots of the tree.

POLYPORUS RIMOSUS.—The Locust is a tree singularly free from most diseases, and so far as known it is attacked by but one fungus which destroys its wood. This one enters through old branch wounds; probably also through the holes made by the locust borer (*Cyllene robiniæ*). It grows rapidly in the hard wood of this tree, destroying the wood cells completely, leaving a soft yellowish mass held together simply by the fungus threads.

POLYPORUS JUNIPERINUS.—The Red Cedar, one of the most valuable timber trees, is very free from fungous diseases. Now and then the wood of older trees is destroyed by the threads of a fungus, which make long holes with a white lining.

PECKY CYPRESS.—This destructive disease of the Cypress, affecting a large percentage of the trees, is probably caused by one of the timber-destroying fungi, the fruiting form of which has not yet been found.

## TREATMENT OF FOREST TREES.

Under the present conditions of forest management, it is not practicable to treat forest trees as one would shade trees, or according to methods used by European foresters. The lumberman can not possibly take cognizance of a dying or infected tree in the forest and remove it for the sake of preventing the infection of other trees. The only recommendation which can be made at present has already been alluded to. Trees become more liable to disease as they grow older, and by a system of careful observation in the forest one can usually detect when the trees are becoming infected. At such times the timber tract in question ought to be cut over to save such timber from entire destruction. On small tracts it may pay now and then to remove the fruiting bodies from trees, but one must not forget that when the fruiting body appears on a tree such a tree is already badly diseased and ought to be cut to save at least a portion of the wood and to prevent other trees from becoming infected. If a number of trees on a given tract are found to be diseased, it may be stated with certainty that the remaining trees are liable to become diseased in a short time, if not already infected, and when other conditions allow it, such a tract had better be cut over, taking the older trees.

## THE RÔLE OF FUNGI GROWING ON DEAD TIMBER.

In the foregoing, the conditions which favor the entrance of fungi into the wood of living trees have been mentioned, and some of the effects which result from their growth. It has been shown that many fungi kill trees outright without injuring their wood, although the destruction of living trees from this cause is rather slight. By far the greater number of trees in our forests are killed by boring insects and by fire. There are many tracts aggregating hundreds of square miles where trees have been killed by one or the other of these agencies. To the lumberman, a tree is valuable because of the wood which it contains, and it matters little whether the wood comes from a live tree or a dead one, so long as the wood is sound. There are many mills, particularly in the West, which refuse to make use of dead timber, simply because it is dead timber; but when it is sound there can be little reason for this refusal. The beetles which kill so many trees do not penetrate farther than the bark, and in no way affect the wood.

FIG. 1.—CROSS SECTION OF WESTERN HEMLOCK TRUNK, 75 FEET FROM THE GROUND, KILLED BY FIRE FOUR YEARS BEFORE, SHOWING RATE OF DECAY CAUSED BY POLYPORUS PINICOLA.

FIG. 2.—CROSS SECTION OF RED FIR TRUNK, 125 FEET FROM THE GROUND, KILLED BY FIRE FOUR YEARS BEFORE, SHOWING RATE OF DECAY CAUSED BY POLYPORUS PINICOLA.

Where fire has simply killed the tree without burning the wood, the latter may still be utilized for lumber.

As soon as a tree dies, a number of fungi attack and destroy its wood, much as those do which occur on living trees, except that their work of destruction goes on much more rapidly. In some cases the sapwood alone is destroyed, in other cases the whole tree. A good deal depends on whether a dead tree remains standing or falls to the ground.

The spores of the fungi enter the wood of a dead tree in various ways. In fire-swept districts the bark of most trees is usually cracked, exposing the charred sapwood, upon which the spores germinate and send their fine threads into the wood cells and medullary rays. These are rich in starch, sugars, and nitrogenous substances, which the fungus seizes upon, and as a result grows rapidly in the sapwood, from which the growth and attendant decay pass to the heartwood.

The number of fungi commonly found on dead timber is very large, but only a few are of such importance as to deserve notice. Foremost among these is *Polyporus pinicola*, whose bright-colored fruiting bodies can be found in all coniferous forests of the Continent (Pl. XXI, fig. 4). Its growth in the wood appears to be a very rapid one, as is shown by the sections in Pl. XXV, figs. 1 and 2. Both specimens shown were cut from trees standing in a burned district, in which the trees had been killed four years ago. The upper section is taken from a hemlock 75 feet from the ground. The lower one is from a Red Fir 125 feet from the ground. It will be noted that the wood of the hemlock has been almost entirely destroyed, while that of the fir is still partially sound. The wood of the Red Spruce (*Picea rubens*) decays almost as fast as that of the Western Hemlock, but accurate determinations with regard to this point are still wanting concerning this tree, as well as concerning most other timber trees. The decay which this fungus brings about is very characteristic. The wood of the conifers turns yellowish, becomes soft, and cracks in many places. The cracks are soon filled with fungus threads, forming sheets or felts which often reach astounding proportions. Ultimately the whole trunk is one mass of finely divided, brittle wood held in place by these sheets. On Pl. XXIII, fig. 1, one can see the white lines of fungus threads distinctly.

After a year the sporophores form on the trunk at numerous points (Pl. XXI, fig. 4) and continue to form for several years, until the tree is entirely decayed. As a result of the growth of this fungus, where the timber on forest lands has been killed, it will be found practically valueless after six or eight years at the most. On Pl. XXI, fig. 3, a tract burned twelve years ago is shown, and one can note the total destruction of the trees.

The rôle which boring insects play in hastening the decay by opening channels through the wood from which the fungus mycelium spreads to the surrounding wood, is merely mentioned here. It may serve to account for the fact that the decay of a large tree takes place with such rapidity, and also for the fact that felled trees resist this fungus longer than standing ones, as the chances for the entrance of the insects into wet wood are much less than for their entrance into dry wood.

### RELATION OF FUNGI TO STRUCTURAL TIMBER.

Besides *Polyporus pinicola* there are a number of fungi which grow on dead timber which are of importance to the engineer and constructor. The spores of these fungi are deposited on sawed timber in the forests, and when placed under favorable conditions they germinate and bring about a process of decay which is very much like that found in live timber. Absence of sufficient air circulation, presence of moisture, and equable temperature are conditions which favor their growth. This is very marked in the case of railway ties, of which many thousands are destroyed by these fungi every year. The position of the tie in the roadbed, surrounded by earth or cinders, brings about conditions on the lower side of the tie extremely favorable to the growth of these fungi, which gradually rot the wood, and ultimately form the fruiting bodies (the conchs, or punks) on the ends of the ties. In buildings, other fungi attack large beams wherever any moisture accumulates, which allows their spores to germinate.

### REMEDIES.

The above facts show clearly that in order to save killed timber from destruction it ought to be cut immediately whenever possible. Its value will depreciate from the moment the tree ceases to live, and before many years have passed it will be utterly worthless. In many sections of this country it is perfectly feasible to cut this dead timber. The cutting of such dead trees not only saves the wood of these trees, but prevents the formation of the fruiting bodies from which infection can spread to other trees. What is true of entire trees, holds for dead wood of any kind. Decayed railroad ties ought to be burned whenever they are removed, and not left to lie by the roadbed for years, forming new fruiting bodies, which constantly infect new ties.

By various processes now in use, a number of salts are injected into timber to prevent the rapid action of the fungus mycelium. As long as these salts remain in the wood the latter is proof against attack, but as soon as the salts disappear by leaching the wood falls a prey to the fungi and decays. At present there is no positive evidence at hand by which to determine how effective any such injection is likely to be.

# RABIES: ITS CAUSE, FREQUENCY, AND TREATMENT.

By D. E. SALMON, D. V. M.,
*Chief of the Bureau of Animal Industry.*

## RABIES IN THE DISTRICT OF COLUMBIA.

In December of the year 1892 the brain of a man who had died of a mysterious nervous affection was brought to the laboratory of the Bureau of Animal Industry for examination. It was thought that the symptoms exhibited by the patient resembled somewhat those of hydrophobia, but the physician hesitated to make this diagnosis, as it was not known that rabies existed among the dogs in the District of Columbia, and as the opinion had been widely circulated by certain authors, supposed to have knowledge of the subject, that the disease was so very rare that a single case could not be found by years of energetic search. A careful consideration of the symptoms, however, led to the inoculation of rabbits in order to test the theory of hydrophobia, and somewhat to our surprise, these rabbits in due time became affected with and died of rabies. As the rabies of animals is identical with the hydrophobia of man, and as hydrophobia is practically always contracted from the bite of a rabid animal, the result of this experiment was a demonstration that the man had died of hydrophobia, with a strong presumption that rabies existed among the animals of this section of the country.

Owing to the supposed infrequency of the disease, this case aroused considerable interest; and when, in the following month (January, 1893), information was received that a horse had been destroyed in the city of Washington because it was thought to be affected with rabies, further inoculations were made from the brain of this animal. The rabbits used in this experiment also became affected with rabies.

About this time a disease of cattle was under investigation by the pathological division of the Bureau, and the conclusion was reached that the disease was rabies; but before making a definite decision it was thought advisable to compare it experimentally with the rabies of dogs. Several veterinarians were accordingly requested to bring to the experiment station all dogs suspected of rabies, and the superintendent of the station shot a number of dogs which appeared to be affected. These dogs were all tested by inoculation experiments, and from March 24 to December 12, 1893, eleven were found affected with rabies.

As the investigations which required the virus of rabid dogs were closed in 1893, no further effort was made to procure cases, and no more were recorded until the fall of 1895. Interest was revived in the subject at that time by the death of a woman in Washington from this dreaded disease. Inoculations were made from the dog which bit this woman, but unfortunately the disease developed in the patient at the same time as in the inoculated rabbits, and there was, consequently, no opportunity for prophylactic treatment. This case was reported by Dr. Behrend to the Medical Society of the District of Columbia, and attracted considerable attention.

Arrangements were now made between the District health officer and the chief of the Bureau of Animal Industry whereby all dogs or other animals suspected of having rabies were to be sent to the Bureau laboratory in order that a positive diagnosis might be made. As a result of all these investigations, the number of cases of rabies which have been positively diagnosed and recorded in animals is as follows: 1893, 11 dogs, 1 horse; 1895, 4 dogs, 2 foxes; 1896, 5 dogs; 1897, 2 dogs, 1 cow; 1898, 7 dogs; 1899, 19 dogs, 1 cow, 1 cat; 1900, January to August, inclusive, 32 dogs, 3 cows, 1 horse, 1 cat. The total number of animals which have been proved to be suffering from rabies in the period from 1893 to August, 1900, is therefore 91. Twenty-eight persons were reported as having been bitten by these rabid animals. The records of the health department of the District of Columbia show 7 deaths of human beings from hydrophobia since August 1, 1874.

These developments were entirely unexpected. It was not supposed before the investigations began that rabies existed to this extent anywhere in the United States. Instead of being an extremely rare disease, to be found but once or twice in a lifetime, even by those who are diligently seeking it for the purpose of investigation, as has been represented, the facts cited show that rabies has existed for years almost continuously at the National Capital.

## THE DISTRIBUTION OF RABIES IN THE UNITED STATES.

In order to learn something of the occurrence of rabies in other parts of the United States, information was requested of veterinary schools, State veterinarians, and other persons who would probably be in possession of such facts. A number of very carefully prepared replies were received, from which the following summaries have been made:

*Dr. Charles P. Lyman, dean of the School of Veterinary Medicine, Harvard University, Boston, Mass.:* During an outbreak of rabies, which was recognized as existing in Boston, there suddenly appeared in Harvard Square, Cambridge, one morning, a large crossbred Newfoundland dog. The animal entered a butcher shop and behaved in such a manner as to induce the butcher to throw him a bone and drive him away. The dog seized the bone and went into the street, and after gnawing for a short time he went one after another to 5 dogs and bit them all. He also bit a horse rather severely in the upper lip. The 5 dogs came under Dr. Lyman's professional care, and 3 of them died, showing all the symptoms recognized and described in the books as belonging to rabies. The wound on the horse was seared with a hot iron probably within thirty minutes from the time the injury was inflicted. Notwithstanding this treatment, the horse contracted the disease recognized and described as being rabies.

During a subsequent outbreak a dog bit a policeman on the streets of Lynn. This man declined to take the Pasteur treatment, said he was not afraid, and would take his chances. Within a short time he was taken ill with symptoms recognized by the local medical men as being those of hydrophobia, and he died after dreadful suffering.

Dr. Lyman estimates that there have been 25 to 30 cases of rabies observed at the Harvard Veterinary School during the last eighteen years.

*Dr. W. J. Coates, chief surgeon of the American Veterinary College, New York:* In looking over record books finds on the average about 7 cases a year for the past twenty-five years. Has never seen a case of rabies in man.

*Dr. H. D. Gill, professor of surgery in the New York American Veterinary College, formerly dean of the New York College of Veterinary Surgeons:* During the month of May last (1900) 3 positive cases of rabies came to the hospital, one dog having bitten the three. For the past three years the average was 8 cases a year.

*Dr. Robert J. Wilson, assistant bacteriologist, department of health, city of New York:* Has confirmed the diagnosis of rabies in about 40 cases in domestic animals, and 3 in the human subject. His attention has also been called to 2 other undoubted cases in that city, where no opportunity was afforded to prove the diagnosis. All of these cases have been observed during the past three years.

*Dr. Wilfred Lellmann, professor in the New York American Veterinary College, formerly of the New York College of Veterinary Surgeons:* Has been lecturing on canine pathology for the past six years. During the last session has demonstrated to the students 4 evident cases of rabies. In his private practice met with 1 case. Of these 5 cases, 4 were mute rabies, while the 1 in private practice was of furious rabies. Besides these 5 cases, he saw 2 more at Dr. Gill's clinic. A physician, Dr. Schwyzer, a friend of his, has observed a case of rabies in a man at the German Hospital in New York City.

*Dr. Leonard Pearson, dean of the department of veterinary medicine, University of Pennsylvania, and State veterinarian:* A great many cases of the rabies have been brought to the hospital connected with this school. Can not tell without looking over a great many records just how many. Estimates that during the fourteen years' existence of the school from 300 to 400 unquestionable cases of rabies have been received in the hospital. Knows of several cases of rabies in man that have occurred in Pennsylvania, and the diagnoses in some of these cases have been confirmed by the inoculation of animals with pieces of the brain. During the last year there have been 2 fatal cases in Lancaster, 1 in Kennett Square, 1 in Philadelphia, and 1 in Allegheny. Three years ago one of the prominent veterinarians of Pennsylvania died of rabies following the bite of a rabid dog. There has been a great deal of rabies among the farm animals in different parts of the State. Cattle, swine, sheep, and horses have developed rabies of the furious form after having been bitten by a mad dog. A great many of these cases have been examined very carefully, and the diagnoses have been sustained by the results of laboratory examination.

*Dr. J. M. Wright, professor in McKillip Veterinary College, Chicago* (writing under date of April 5, 1900): Since January 1, 1900, his attention has been called to 11 cases in the dog and 3 in the horse. During the last year he has handled 20 cases, which is a fair yearly average.

*Dr. A. H. Baker, professor of theory and practice and dean of Chicago Veterinary College:* "Many cases of rabies in dogs and horses have been brought here. We have kept no record of the number of cases, but I can safely say that during the last year we have had at least 10 cases in horses and 50 in dogs. I have never seen a case of rabies in man. I may add that we are sincere believers in the Pasteur preventive treatment for rabies in man."

*Dr. James Law, director of New York State Veterinary College, Cornell University, Ithaca, N. Y.*, says:

"This particular locality has never, to my knowledge, since 1868, furnished a single case of *casual* rabies. It has, however, been repeatedly sent to us from different parts of the State (Chatham, Saratoga, Buffalo, etc.) in the form of brains of the diseased animals, from which small animals were experimentally inoculated and the disease produced, so as to confirm the original diagnosis or suspicion.

"I know of the case of Neil, the keeper of the dog pound at Newark, N. J., who died of rabies consequent on the bite of a rabid dog. I brought a portion of his medulla to Ithaca and inoculated a dog and a number of rabbits, some on the brain and others subcutaneously, with the result that all showed rabies after the customary periods of incubation. I have the best of evidence of a number of men who contracted rabies after the bite, and from whom (saliva or brain) inoculation of the disease was successfully made on the lower animals to prove its infective character.

"On the other hand, I know of a number of cases in which people who had been bitten by dogs have developed symptoms of hydrophobia as the simple result of fear, mimicking the symptoms as nearly as their knowledge of the disease would guide them. * * * The unreal nature of such fanciful cases is not, however, any disproof of the actual infections in which the virulent saliva or brain of the human victim has produced rabies in the lower animals in a continuous series, though they can have no apprehension of such a result. The person who denies the real because there exists a counterfeit is in this case an exceedingly dangerous person, about as much in need of seclusion as the rabid dog itself. The disease prevails at present in Erie County, N. Y."

*Dr. S. Stewart, secretary Kansas City Veterinary College:* Eleven or 12 cases have been brought to the hospital during the last three years, 5 within one year. No cases of rabies in man have come under his personal observation. Four or more authentic cases have occurred in that city in past five years. Typical, well-marked cases in dogs, horses, cattle, and swine have come under his personal observation.

*Dr. John J. Repp, professor of pathology and therapeutics of veterinary department, Iowa State College of Agriculture and Mechanic Arts*, says:

"Since my connection with this school, a little over a year, no case of rabies has been brought to it. By consulting the records, I find that no case of rabies has been brought to this school during the twelve years covered by them. * * *

"During the past winter Dr. J. R. Sanders, Corydon, Iowa, has noted the death of 18 cattle in his vicinity, 7 out of one herd of 50, all showing rabiform symptoms. He killed one of the seven out of the herd of 50 when it was suffering from these symptoms in a violent form, removed the cerebellum and medulla oblongata, according to my direction, and sent them to me packed in ice. I received the tissues in excellent condition, and at once inoculated a rabbit subdurally with a small portion of a mixture made with sterile water and about one-eighth of a cubic centimeter of the medulla cut from the floor of the fourth ventricle. On April 7, two weeks and four days after the inoculation, the rabbit died, after four days' suffering, from gradually increasing paralysis. * * * My diagnosis, therefore, is that the steer from which the tissues were taken was suffering from rabies at the time of his death, a diagnosis borne out by the symptoms presented. If this steer had rabies, it is presumed that the other cattle suffering in like manner had rabies also.

"During my four years' residence at the University of Pennsylvania I saw a large number of cases of rabies in the dog and made a number of rabbit inoculations from such cases with invariably positive results. Rabbits which I inoculated in the same manner from suspected but doubtful cases frequently remained perfectly well, showing that the mere operation will not bring on the symptoms of paralysis and death, and leading to a decision that the suspected cases were not rabies."

*Dr. H. J. Detmers, Columbus, Ohio, formerly professor of veterinary medicine in Ohio State University:* Has observed 4 very pronounced and unmistakable cases, 3 dogs and 1 horse, since 1893.

*The health department of Buffalo, N. Y.:* In a recent outbreak, not yet entirely over, investigated, on complaint, 45 cases in dogs; in addition 74 cases of dumb rabies and 41 cases of furious rabies were brought to the pound. Inoculations were made early from the case of a stray dog that ran amuck at Evans, biting 17 dogs and 2 cats. The dogs inoculated developed typical rabies on the twenty-third day following.

Records of the county superintendent of poor and the city department of health show that 29 persons were sent to the Pasteur Institute at New York, 4 of these being bitten by rabid cats. Four persons died of the disease—the first, a child, eighty-one days after being bitten; the second, the owner of the dog which bit the child, who was sent to the Pasteur Institute at New York, dying there, the disease in him developing on the eighty-third day; third, a young man, bitten by strange dog which he was trying to throw out of a crowded dancing hall, and which was acting strangely; fourth, a woman, who died in October, 1899, having been bitten by a dog. A considerable number of animals other than dogs also died of the disease.

*Dr. A. W. Bitting, veterinarian of the Agricultural Experiment Station of Indiana* (writing under date of April 18, 1900), says:

"Your letter was received on the 10th, and upon the 11th we had a typical case of rabies in a dog at this station. This makes the third outbreak at this place. One outbreak occurred last August and September, in which 1 dog, 7 horses, and 8 head of cattle died. Part of these were brought to the experiment station laboratories. The first outbreak occurred some years ago, and some two or three dogs in the neighborhood and several sheep and hogs belonging to the station were affected. A number of outbreaks have been reported in the State. I have never seen a case of rabies in man, but our State board of health records 3 deaths from such a cause last year."

*Dr. C. A. Cary, professor of veterinary science in Agricultural and Mechanical College of Alabama:* Six cases have been brought to the college and many others have occurred in the vicinity; altogether 24 cases of rabies are recorded at the college.

*Dr. J. W. Scheibler, State veterinarian, Memphis, Tenn.:* Has seen about 20 cases of what he believed to be rabies.

*Dr. George H. Bailey, State veterinarian, Portland, Me.:* Has had 1 case in his private practice, and the Maine general hospital had 1 case in a young man several years ago.

*Dr. A. W. Clement, State veterinarian, Baltimore, Md.:* Has had about 30 cases brought to his attention officially.

*Dr. Samuel S. Buckley, veterinarian at Maryland Agricultural Experiment Station, College Park, Md.*, says:

"We had, several years ago, an outbreak in this town, originating, as far as we know, in a collie. This animal, in the course of his depredations, bit 3 cows, a cat, a calf, and the farm superintendent and his son. All the animals developed the disease before being destroyed. The farmer and his son were treated by Dr. Gibier, of New York, and never suffered any trouble."

*Dr. Cooper Curtice, State veterinarian of North Carolina:* Although he has been in that State but about a year, he has noted 1 case there in the human subject.

*Dr. W. H. Dalrymple, veterinarian, State University and Agricultural and Mechanical College, Baton Rouge, La.:* Has seen 1 typical case of rabies in the horse and at least half a dozen cases in cattle. From an interview with Dr. J. W. Dupree, surgeon-general of the State and ex-president of the State Medical Association, he learned that the latter has had in his practice 3 typical cases in the human subject resulting from the bites of dogs. The dogs were not destroyed but kept under observation, and they died, showing typical symptoms of the disease.

*Dr. F. A. Bolser, State veterinarian of Indiana:* Three outbreaks of rabies in six years, affecting horses, mules, cattle, and hogs. Two young men were bitten, badly lacerated, and died in great agony.

*Dr. H. P. Clute, State veterinarian of Wisconsin:* Fourteen cases in dogs, sheep, cattle, and horses. A successful inoculation of rabies with virus taken from the brain of a calf and dog has just been made at the experimental station at Madison. The calf died, having been bitten by a sheep that was bitten by a dog. All of these animals died of rabies. Rabbits inoculated with virus from the brain of the dog on March 15 died of rabies on the eighteenth and nineteenth days after inoculation. Those inoculated with virus from the brain of the calf died of rabies on the twenty-first and twenty-second days after inoculation.

*Dr. A. T. Neale, director of Delaware Agricultural Experiment Station:* Has seen many cases of rabies during the last ten years. Horses, cows, and dogs have been the victims. Has no complete record of the number of cases. Specifies the following cases:

(1) A cow, seen before death, was killed two days later, and medulla and section of cord removed and taken to University of Pennsylvania, where rabbits were successfully inoculated. Ten days later these inoculated animals died of dumb rabies. This cow was one of three or four in the same herd which died with similar symptoms.

(2) Inoculation from a suspicious dog at experiment station on rabbit caused death by paralysis ten days later.

(3) A horse observed at 10 a. m. died after four or five hours; was undoubtedly affected with rabies. No inoculation test made.

Two or three dog cases have been demonstrated by Professor Chester and Dr. Robin at this station since last summer. In every instance rabbits have been the test animals, and in every case the rabid dogs have been under observation for several hours prior to death.

Dr. H. P. Eves, of Wilmington, Del., has many cases of cows and dogs in his practice, victims of this disease. Dr. J. J. Black, of Newcastle, has had human cases in his practice.

*Dr. M. E. Knowles, State veterinarian of Montana:* Has seen about 60 cases of rabies during a practice of fifteen years, of which 53 cases were brought to his attention officially.

*Dr. J. W. Elliott, State veterinary surgeon of South Dakota:* Has had as many as 100 cases brought to his notice officially in the last two years, mostly in cattle, and the origin could be traced to dogs afflicted with rabies.

*Dr. G. T. Seabury, State veterinarian of Wyoming:* Destroyed a dog affected with rabies in Cheyenne on March 30, and has seen 3 cases of the disease.

*Dr. Sol. Bock, State veterinary surgeon of Colorado:* Has seen at least 50 cases of rabies in the past year.

*Dr. Paul Fischer, State veterinarian and professor of veterinary science and pathology of Kansas State Agricultural College:* Reports a case of rabies in a horse in 1897. The animal was brought to the college and showed very characteristic symptoms. It had been bitten by a rabid dog three weeks before. The animal died on the following day. Intracranial inoculation of a rabbit with portion of cord of the horse produced death after thirty days from paralytic rabies.

*Dr. A. T. Peters, animal pathologist at University of Nebraska:* Reports about eight different outbreaks of rabies recorded there. In one outbreak a dog bit several other dogs, and also a cow and a horse. The cow, a fine Jersey heifer, was bitten in the nose. She was quarantined, and thirty-one days afterwards showed all the symptoms of rabies. The horse was bitten very slightly, and showed the disease some two hundred days later.

*Dr. L. L. Lewis, professor of zoology and veterinary science at Oklahoma Agricultural and Mechanical College:* Two cases of rabies have come under his observation since he has been in that position.

At this writing (December, 1900) information is received from Dr. George W. Coler, health officer of the city of Rochester, N. Y., of an extensive outbreak of rabies in that city and vicinity. Dr. Coler has officially reported to the mayor that since June 1 he has seen from 25 to 50 dogs with unmistakable evidences of rabies, a number of the animals having been shown to be rabid by inoculation experiments, which in 4 cases were verified by Prof. V. A. Moore, of Cornell University, and Dr. M. P. Ravenel, of the University of Pennsylvania. Upon the recommendation of the health officer, the mayor has issued a proclamation ordering "that, until further notice, the owners of dogs are prohibited from allowing them to run at large in any public street or place within the city of Rochester, unless such dogs be securely muzzled or led by a line or chain so as effectively to prevent them from biting any person or animal."

In a valuable article published in the St. Paul Medical Journal, October, 1900, Dr. F. F. Wesbrook, director of State board of health bacteriological laboratory and professor of pathology and bacteriology in the University of Minnesota, details investigations of specimens from suspected cases of rabies, from which he concludes:

It is very evident that rabies does exist in this State and is fairly widespread in distribution and number of cases. The cases examined, and which proved to be rabies, include 1 human being, 20 dogs, 1 horse, 7 cattle, 1 pig, 1 sheep, and 1 wolf. We have histories which show that infection was known to be due in these cases to the bites of 19 different dogs, and perhaps 1 skunk, in which rabies infection may be assumed from the demonstration of rabies virus in the cases bitten by them. We have also data which show that at the time of the infection of the cases investigated by the laboratory 1 man, 8 dogs, 8 cattle, 6 swine, and 6 sheep were known to have been bitten, and of these, 8 cattle, 6 swine, 6 sheep, and 3 dogs died of rabies—that is, all of the cattle, swine, and sheep developed rabies. The man received Pasteur treatment.

The animals which were thus shown to have had rabies on laboratory investigation are known to have bitten 7 human beings, 3 dogs, 6 cattle, 1 horse, and 5 hogs. Of these, 5 of the people received Pasteur treatment, and none, so far as is known, developed rabies. Of the animals bitten, 5 cattle, 1 horse, 1 hog, and 4 dogs developed rabies and died or were killed. Many more of the dogs known to have been bitten were killed before rabies had a chance to develop. As an example, it may be mentioned that in Willmar 30 were killed at one time. These estimates have been carefully made, and where the information at hand stated that several animals had been bitten, account was taken only of one.[1]

It will, therefore, be seen that from these 46 cases examined, of which 31 were shown to be rabies, and concerning which there was data in only a small portion of the cases, we have been able to obtain positive knowledge of 84 cases of rabies in this State. (See table below.)

| Items. | Human beings. | Horses. | Cattle. | Sheep. | Swine. | Dogs. | Wolves. | Total. |
|---|---|---|---|---|---|---|---|---|
| Rabies diagnosed by laboratory, Minnesota State board of health.. | 1 | 1 | 6 | 1 | 1 | 20 | 1 | 31 |
| Animals which bit the animals shown by the laboratory to have been rabid | ....... | ....... | ....... | ....... | ....... | 19 | ....... | 19 |
| Animals which developed rabies and died from bites inflicted under the same circumstances as those animals which were shown to have been rabid by laboratory investigation | ....... | ....... | 8 | 6 | 6 | 3 | ....... | 23 |
| Animals which developed rabies after having been bitten by animals shown by the laboratory to have been rabid | ....... | 1 | 5 | ....... | 1 | 4 | ....... | 11 |
| Total | 1 | 2 | 19 | 7 | 8 | 46 | 1 | 84 |

In the Fifth Biennial Report of the West Virginia State Board of Agriculture for the years 1899 and 1900, Dr. S. E. Hershey, consulting veterinarian, states that quite a number of outbreaks of rabies have occurred within that State in the past few years, with considerable damage and loss of stock. He gives, as coming under his personal observation during the period covered by the report, 4 cases of cattle and 1 of a horse, 4 of which animals were known to have been bitten by dogs. In addition there were many similar cases in the same herds or on the same farms which he did not personally see. In Lewis County several horses died with rabies and several people were bitten. Some of the people were sent to the Pasteur Institute at New York for treatment. Several deaths occurred in the human family in that county.

The Biennial Report of the State Veterinary Sanitary Board and the State Veterinary Surgeon, of Colorado, for the years 1899 and 1900, contains this paragraph:

> Last year an epizootic of rabies occurred in this State, but the outbreaks in all cases have been vigorously handled by the local health authorities, and at the time of making report the epizootic may be considered to be effectually suppressed.

[1] This statement apparently explains the inconsistency of some of the figures, and indicates that in some cases they are below the actual number.

In the vital statistics of the census of 1890, the deaths from hydrophobia in man are reported by States for the year ending May 31, 1890, as follows:

| | | | |
|---|---|---|---|
| Alabama | 7 | Missouri | 11 |
| Arkansas | 4 | Nebraska | 2 |
| California | 1 | New Hampshire | 1 |
| Colorado | 2 | New Jersey | 3 |
| Connecticut | 2 | New Mexico | 6 |
| Florida | 2 | New York | 5 |
| Georgia | 16 | North Carolina | 3 |
| Illinois | 3 | Ohio | 3 |
| Indiana | 4 | Pennsylvania | 6 |
| Kansas | 3 | South Carolina | 6 |
| Kentucky | 5 | South Dakota | 1 |
| Louisiana | 5 | Tennessee | 5 |
| Massachusetts | 21 | Texas | 3 |
| Michigan | 2 | Virginia | 2 |
| Minnesota | 4 | | |
| Mississippi | 5 | Total | 143 |

The results of the census of 1900 not being available, application was made to the health officers of the principal cities of the United States for the number of deaths from hydrophobia in man during the decade from 1890 to 1899, according to their official records. The reports received, to which have been added a few cases reported from unofficial but reliable sources, show that for the period named, and including in some instances the first half of the year 1900, there were in 73 cities 230 deaths from this disease after eliminating cases in which the diagnosis was reported as doubtful. The figures for some of the leading cities are as follows:

| | | | |
|---|---|---|---|
| Greater New York | [1] 27 | Buffalo | [3] 4 |
| Chicago | 68 | Pittsburg | 7 |
| Philadelphia | [2] 8 | Washington | 5 |
| Baltimore | 8 | Nashville | 5 |
| New Orleans | 14 | | |

In a number of these cases the diagnoses were verified by inoculations of small animals with material from the human subjects.

[1] Incomplete, as the records of some of the boroughs did not go back for the whole period.

[2] Only 6 of these cases are officially reported by the health department, and these are all prior to 1897. In one of the remaining cases inoculation experiments were made with positive results, and the other is well authenticated, though the coroner is reported as refusing to accept certificates of death from hydrophobia, and requiring that the certificates be made to ascribe the deaths to other diseases.

[3] All occurred in 1900. No report was received covering the period previous to this outbreak.

## FACTS AND FALLACIES CONCERNING RABIES.

It required many years of patient scientific research to lead the ablest investigators to a clear comprehension of the cause, nature, and characteristics of rabies, and it is only recently that this has been accomplished. From the earliest dawn of history the disease has been feared and dreaded; its terrible manifestations have been surrounded with an atmosphere of awe and mystery, and it is not surprising that myths, fallacies, and misconceptions in regard to it have been common and widely accepted. Nor have such errors been confined to the ignorant or those unfamiliar with the subject of disease, but, on the contrary, they have been shared and propagated by men of learning, some of whom have stood high in the medical world.

As the investigations by which we have come to a tolerably clear understanding of the facts concerning rabies have been comparatively recent, and have appeared for the most part in scientific periodicals, fallacies in regard to the disease still have a strong hold upon the public mind, and are industriously circulated by many who believe they are working in the cause of truth and humanity. Persons in a position to know the facts have either not had the time, the disposition, or the opportunity to take up this subject and show its importance to the people and the desirability of educational work with a view to the control of the contagion. For years we have been living in fancied security from this disease; we have been told that it was extremely rare, if, indeed, it had any existence outside the imagination; and during these years the plague has spread, with only the feeblest efforts for its control, until now it has become so common as to be a positive and constant menace to our animals and to human life. The facts already presented demonstrate its frequency, but they do not give an adequate idea of the losses from it.

In many sections where it exists its nature is not recognized. Some outbreaks, in which most of the cases were of the dumb or mute form, were not recognized even by veterinarians. One such case, where 50 or 60 dogs were reported affected, was so characteristic in symptoms that its nature could not be doubted. The "dropping" of the jaw and the uniformly fatal results after a few days' illness attracted attention, but apparently did not excite suspicion. In the Rochester outbreak so many cases of dumb rabies occurred that the disease was popularly known as "drop jaw." Three animals so affected, the health officer states, were found in one load of dogs that was taken to the pound.

In order to convey a clear idea of the subject, some of the principal questions concerning rabies will be briefly considered *seriatim.*

### THE REALITY OF RABIES.

The first point in regard to which the earnest inquirer seeks information is the reality of rabies. Is there a particular and well-defined disease which can be clearly determined and separated from all other diseases, and which conforms to the description that has become classical in our text-books and has been accepted for generations? In other words, Do we know there is such a disease as rabies? and, if so, How do we know it?

### GENERAL RECOGNITION OF SUCH A DISEASE AS RABIES.

From the time of Aristotle (322 B. C.) till the present day we have clear accounts of this disease existing through every age, and provoking fear and horror in many countries. It was caused by the bite of an animal, and such animal was generally alleged to be rabid. It was almost invariably described as fatal in men and animals. The symptoms, from the earliest times, have been given as nervousness, excitability, restlessness, fear, irritability, great sensitiveness of the skin, paroxysms of fury, spasmodic contractions of certain muscles, paralysis, and death.

The medical profession, as a whole, has always recognized the existence of such a disease as rabies in man, and also that this disease is caused by the bite of a rabid animal. The veterinary profession has, from its foundation, recognized the existence and contagiousness of the disease. Its schools, from the earliest to the latest, have consistently taught this doctrine, and its text-books are all but unanimous on the subject. The same may be said of the text-books on human diseases. Would it not be extraordinary, amazing, incredible, if, at this late day, it were proved that the thousands and hundreds of thousands of observations recorded from the birth of history to the present day, by the trained physician or veterinarian as well as by the layman, were misconceptions, that the authors were deceived, and that the disease was a myth? Where can a parallel be found to such a sudden and complete overthrow of an ancient and almost universally accepted conclusion concerning a phenomenon so accessible to observation and investigation?

### INSUFFICIENCY OF OBSERVATION TO PROVE THE DISEASE.

There have, however, apparently been a few persons in all ages who have questioned the existence of rabies. The mysterious and unusual phenomena were sufficient to explain this doubt on the part of thinkers and writers without personal experience with the disease, or who approached its study with preconceived opinions. Previous to the nineteenth century it was difficult to answer the objections of such critics. At the most, it could be affirmed that cases of a disease with such a train of symptoms had been observed, and that this disease followed the bite of a dog supposed to be rabid. It could not be proved that the dog which did the biting actually was rabid, or that the disease certainly resulted from the bite, or that the disease in the dog and the man were identical.

### EXPERIMENTATION MARKS A NEW ERA IN THE MEDICAL WORLD.

With the beginning of the century came a new era in the medical world. The student of disease began to feel the necessity for a more substantial foundation for his knowledge than the ordinary observation of the accidental cases which from time to time occurred in his practice. These accidental cases were often too widely separated for comparative study, the conditions under which they developed could not be known or controlled, and the essential phenomena could not be determined. Observations made and conclusions reached under such circumstances were unreliable. Different observers would reach diametrically different opinions, and one apparently had as good evidence for his views as the other. The confusion and absurd hypotheses which resulted can only be realized by comparing the text-books of a century ago with those of the present day.

The doubts, errors, and confusion which arose in the attempt to study disease by the observation of accidental cases were finally dispelled by experimentation. What could be more rational, for example, in case there was a doubt as to the transmission of canine madness by biting, than to make an experiment by allowing a rabid dog to bite four or five other dogs and to keep an equal number unbitten for comparison. If the bitten dogs contracted rabies and the unbitten ones remained free that would be presumptive evidence of transmission. Such an experiment, repeated perhaps a few times, with precautions against accidental infection, would afford positive demonstration as to this essential point in our knowledge of the disease.

### DEMONSTRATION OF RABIES BY EXPERIMENTATION.

Zinke,[1] in 1804, announced that he had inoculated a dog, a rabbit, and a cock with saliva from a rabid dog, taking the saliva with a brush from the animal soon after its death and spreading it over superficial wounds of the inoculated animals. The dog was inoculated in an anterior limb, and showed prodromic symptoms on the eighth day, and was rabid on the ninth day. The rabbit was rabid on the eleventh and the cock on the fourteenth day.

This experiment, made so early in the century, proved (1) the virulence of the saliva of rabid dogs; (2) that the disease might be artificially inoculated; (3) that the disease might be communicated by inoculation to the dog, the rabbit, and the fowl; and, (4) it disproved the old doctrine that the contagion disappeared at the instant of the animal's death (*morte la bête, mort la venin.*)

Count Salm-Reiferscheid, in 1813, recorded experiments in which several dogs were inoculated, part with fluid and part with dried saliva from a rabid dog. These were affected with rabies in eight to ten

[1] Zinke, Gottfried: Neue Ansichten der Hundswuth, etc., Jena, 1804, S. 180. Quoted by A. Högyes: Lyssa, Wien, 1897, p. 32.

days. This experiment proved that the saliva remained virulent a considerable time after the dog's death, and that it would even withstand a certain amount of drying.

These two series of experiments give us the evidence of the existence of a specific, communicable disease of the dog, which is transmitted by inoculation with the saliva. There was still a question as to whether cattle and sheep, animals which do not naturally defend themselves or combat others by biting, developed virulent saliva when they contracted the disease. To determine this, Berndt, in 1822, inoculated four wethers with saliva from the mouth of an ox which had died of rabies. All of these sheep contracted rabies, the period between inoculation and the appearance of the first symptoms being twenty-two, twenty-five, twenty-six, and thirty-one days.[1]

In 1841–42 Professor Rey, of the Veterinary School of Lyons, France, inoculated from sheep to sheep, using the saliva and inserting by lancet punctures. Of 7 animals inoculated in this manner, 6 contracted the disease.[2]

Renault reported that from 1836 to 1860 he had inoculated or caused to be bitten 131 dogs in his experiments, and that 68 of these afterwards became affected with rabies. The period of incubation varied with these animals from ten days to one hundred and eighteen days, and with about 18 per cent it was sixty days or longer.[3] This report gave much information as to the proportion of inoculated dogs which contracted the disease and as to the period which may be expected to elapse between the inoculation and the appearance of the symptoms.

There were many persons, including physicians, who at the beginning of the century doubted the transmission of rabies to man. The medical doctrines at that time were unfavorable to the idea of contagion, and the inclination was to look upon rabies as a simple irritation of the central nervous system. These views were exploded by Magendie, who inoculated a dog under the skin of the frontal region with the saliva of a young man under treatment for rabies. This dog became rabid in about a month, and was allowed to bite 2 other dogs, which in turn became rabid after forty days.[4]

Earle, Hertwig, Renault, and others made similar inoculations from affected persons to rabbits, conveying the disease. It was also shown that children so young that they could not cause the disease by worry and dread were affected by the bites of rabid dogs in the same manner as adults.[5]

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[1] Journal der practischen Heilkunde. C. W. Hufeland, November, 1824, pp. 59–61.

[2] Rey: Expériences sur la Rage. Journal de Médecine de Lyon, December, 1842, p. 461.

[3] Comptes Rendus Acad. des Sciences, 1863, p. 72.

[4] F. Magendie: Journal de Physiologie Expérimentale, 1821, p. 42.

[5] Tardieu: Discussion sur la Rage. Bul. de l'acad. de Méd., 1863, p. 1152.

It was, consequently, demonstrated that rabies is communicable to man as well as to animals, and that the saliva becomes virulent with man, as it does with the lower animals.

The diagnosis of rabies has been called in question in all ages, and there have always been persons who have asked, How do you know that this particular animal or that this individual person is affected with rabies and not with some other disease of the nervous system? The answer of the investigator is: If inoculations from this animal or this person transmit the disease to the inoculated animals, then it is certain that the individual from which the inoculation was made was affected with the disease, that is to say, rabies can not be produced with the saliva of animals or men affected with noncontagious diseases, nor is there any other known contagious disease with similar characteristics which may be confounded with rabies. The inoculation or biological test is therefore an accurate and reliable test, and should be used in all cases of doubt. It is identical in principle with the biological tests of glanders, pleuropneumonia, foot-and-mouth disease, rinderpest, variola, and other contagious diseases of animals which have long been used and relied upon in case other methods of diagnosis fail.

The value of rabbits for making the biological test of rabies was pointed out by Galtier in 1879 and by Pasteur a few years later. The obstacles to this test in practice were (1) that the saliva generally contained various kinds of bacteria and might cause the death of the rabbits from septic infection, and (2) that the period of incubation might be long and uncertain when cutaneous or subcutaneous inoculations were made. The investigations of Pasteur (1881) showed the constant virulence of the brain and medulla, and that these organs, being protected from saprophytic germs, furnished a pure virus which might be used for biological tests. He also showed that the inoculations might be made upon the surface of the brain, in which case the disease was certainly transmitted, and the period of incubation was reduced to a minimum.

Of late years the methods of Pasteur have been widely adopted. There are still skeptics, however, who object to this test, on the ground that it is the irritation to the brain, caused by the inoculation, that produces the disease, and that there is no proof of contagion when the rabbits die of supposed rabies. These people forget, however, that it is always possible in case of doubt to make the inoculation in the skin or muscles, or even to use larger animals, such as horses, cattle, sheep, or dogs. Rabbits are only used because they are cheap and convenient. Brain inoculations are made because they are more certain in results and the disease appears sooner. The Pasteur method has been sufficiently confirmed by other methods, and its reliability clearly demonstrated.

Successful experiments of this order, numerous, and made by competent men, are absolutely conclusive as to the existence of a disease of the dog communicable to human beings, to dogs, and other animals by biting and by inoculation with the saliva. If this disease is not rabies, what is it? And if it is given some other name, do not the facts stand the same under one name as under another?

It is a mistake to say that the disease alleged to be rabies has not been defined with sufficient clearness for its identification. Consider for a moment the description: A disease affecting principally the nervous system, shown by nervousness, excitability, restlessness, irritability, paroxysms of fury, uncontrollable desire to bite all other animals, convulsions, paralysis, death; caused by the bite of an animal similarly affected; communicable by inoculation with the saliva; having a long period of incubation (three to six weeks); comparatively short course of disease (two to ten days); invariably fatal. Is not that picture clear enough for identification? With what other disease can it possibly be confused?

The reality of rabies has been demonstrated by crucial experiments, so often repeated that there is no longer any reason for doubt. It is a fact established with the same certainty as any other fact in science, and it can not be overthrown by hypothetical arguments or general denials based upon intuitive reasoning.

THE COMMUNICABILITY OF RABIES TO MAN.

Aristotle taught that rabies was fatal to dogs and to every other creature which they bite except mankind. This early mistake as to the immunity of man has been carefully handed down across the succeeding twenty-two centuries as though it were the most precious bit of knowledge, and is still repeated on every hand by the many who oppose measures for the prevention of the disease. There was some apparent support for this opinion in a number of facts connected with the disease. First, only a portion of the persons bitten by rabid dogs subsequently show symptoms of the disease; taking all the statistics available, not more than one individual in every six thus bitten is found to contract rabies even when no prophylactic treatment is administered. Second, there are other abnormal conditions of the nervous system in man which are accompanied by symptoms resembling more or less closely those ascribed to rabies. Third, some persons who have been bitten by dogs not rabid have by constant worry, anxiety, and fear of rabies induced a nervous, hysterical condition, with symptoms simulating somewhat those of the actual disease.

With these known facts as a basis, it is not surprising that a certain number of writers of limited experience and the habit of superficial observation should reach the conclusion that the view of Aristotle was correct, and that the disease was not transmissible to man. They argued that it was only the comparatively few nervous and excitable people among those bitten who afterwards presented symptoms of rabies, and that these few had brought on these symptoms themselves by worry and fear, being affected not with true rabies, but with lyssaphobia (fear of rabies), which is simply a nervous and hysterical condition.

This reasoning was quite plausible a century ago, but it received a definitive answer when Magendie and other investigators inoculated dogs and various other animals from human victims of the disease, reproducing it in typical form. These experiments proved most conclusively that man as well as the lower animals is subject to rabies, and that when so affected his saliva becomes virulent, and may be the means of communicating the malady.

At present, when it is desired to make a positive diagnosis in a case of suspected rabies, this is done by the inoculation of some animal, usually a rabbit. Objection has been made by some critics to results obtained by inoculation of small animals, on the ground that the symptoms of the disease with such animals are not sufficiently characteristic to warrant a positive conclusion. This objection has little weight, since the long period of incubation (fourteen to twenty-eight days), the sudden appearance of the symptoms, the paralysis, and the short course of the disease, ending in death, are not likely to be seen in any other disease. In case of doubt, it is always possible to inoculate a larger animal, such as a dog, calf, or sheep, and thus reach an incontestable decision. The results of rabbit inoculations have been confirmed so many times by the inoculation of other animals that there is no longer any reason to doubt the occurrence of rabies in mankind or the reliability of the diagnosis by the usual tests.

Numerous cases of rabies in the United States affecting the human subject have been reported from various parts of the country, and tests have been made by our most competent investigators. These tests show that the disease not only exists, but that it is far more common than has been generally admitted. The extensive outbreaks of the disease in dogs reported from Buffalo, Rochester, and Washington City during the past year, and the numerous smaller outbreaks which have occurred in widely separated localities, are disquieting, and show the importance of more systematic repressive measures. A considerable number of persons, mostly children, have been bitten in these outbreaks, some of whom have died after the most intense suffering. Others have taken the Pasteur treatment, at great expense and inconvenience.

These are the facts in regard to the occurrence of rabies in man and animals in the United States. When the medical statistics of other countries are consulted there is found in many of them the same conditions. In Austria, Belgium, France, Germany, and Russia the official reports show a large number of cases of rabies in dogs and other animals each year and a certain number in man. These are among the most enlightened countries of the world, where medical science has achieved its highest advancement, and where the theory of error on the part of the health authorities in regard to the nature of the disease is out of the question.

Such facts are met by the assertion that one prominent physician in Philadelphia has been endeavoring to find a case of rabies in man or in one of the lower animals for sixteen years without success; that another physician in New York has not been able to satisfy himself of the reality of the disease after many years of investigation, and that a neurologist in Washington City has publicly offered a reward of $100 for a case of rabies in man or dog. These assertions are plausible, and to those unacquainted with all the facts, they may be convincing. In reality they are deceptive and misleading. There have been numerous cases of rabies in dogs brought to the veterinary department of the University of Pennsylvania every year for many years, and any physician in Philadelphia could make arrangement with that institution to see and study the cases if he so desired. In the same manner any reputable physician in New York could have arranged with one of the veterinary schools or with the board of health in that city for a similar opportunity. There have been also rather frequent reports in the medical journals of patients at the hospitals in that city affected with this disease, and in some cases inoculation tests have demonstrated the correctness of the diagnosis. How can it be possible that a prominent physician living there and presumably well acquainted with the members of his profession has diligently searched for years for such cases and failed to find any? As to the neurologist in Washington City, the writer publicly answered his advertisement, and proposed to produce a case of rabies, the genuineness of the disease to be decided by a committee appointed by the Medical Society of the District of Columbia, and the reward, if earned, to go to a charitable purpose. The gentleman, however, did not accept the proposition, but withdrew his advertisement, and apparently had no further desire to see a case of the disease.

## THE FREQUENCY OF RABIES.

Some idea of the frequency of rabies in the United States may be obtained from the facts which already have been given. The cases mentioned are, however, only a few of what have occurred in the country, since the inquiry which elicited them has been by no means extensive or exhaustive. It was nevertheless sufficient for the purpose, which was to show the wide distribution and comparatively frequent cases of the disease. It may be safely concluded that instead of being a much more rare disease than is generally supposed, it is a much more common disease than we had reason to expect.

In many other countries the disease is equally prevalent. The official reports of Germany show 1,202 cases of rabies in animals (mostly dogs) in 1898. In France there were 2,374 animals affected in 1899. In Belgium there were 444 cases. In Great Britain there were 727 cases in 1895, and in Hungary 1,397 cases in the same year.

It is frequently asserted as an argument against the existence of rabies, that it is unknown at Constantinople and in India, where dogs are common and unrestrained. But why go to distant countries, from which it is difficult or impossible to get accurate information, for arguments on this subject, when the disease exists in our own cities, where it is accessible and may be investigated. If the condition of New York City, with its newspapers, board of health inspectors, veterinary schools, and highly intelligent population, is misrepresented, what may not be said of Turkey and India without fear of successful contradiction!

Whether rabies is or is not frequent in the Orient has little bearing on its existence here. What we know is that the disease is or has been common in all of the highly advanced and best known countries of the world. Our investigations show that it is equally common in the United States. These facts can not be overturned by the citation of reports from other countries, even if the accuracy of such reports were satisfactorily established. The frequency of rabies in the United States can only be determined by careful scientific investigations here, and not by reports from elsewhere. The cases cited from European countries have been produced simply to show that the disease was common there as well as here, that it is recognized by scientific authorities and by the leading governments, and that, consequently, the statement sometimes made to the effect that the highest authorities in the world deny the existence of rabies is incorrect and without foundation in fact.

### THE EFFECT OF SEASONS UPON THE DEVELOPMENT OF RABIES.

Homer is supposed to refer to rabies when he mentions the dog star, or Orion's dog, as exerting a malignant influence upon the health of mankind. This ancient belief has come down to our times, many intelligent people still holding that it is principally during the dog days that rabies develop, and that the disease can not exist during the cold months of the year. The scientific study of the disease and the statistical records show, however, that rabies is prevalent in winter as well as in summer, and that if the season has any influence upon its development this influence is not very marked.

Bouley[1] compiled statistics showing 755 cases in December, January, and February; 857 in March, April, and May; 788 in June, July, and

[1] Dict. de Méd. de chir. et d'hyg. vet. Zundel, Paris, 1877, p. 348.

August; and 696 in September, October, and November. At the Alfort Veterinary School for the years 1887, 1888, 1889, and 1890 the cases were as follows: January, February, and March, 130; April, May, and June, 60; July, August, and September, 50; October, November, and December, 74.

The following table, giving a large number of cases by months, has been compiled from statistics at hand:

*Cases of rabies in dogs, by months.*

| Source. | Jan. | Feb. | Mar. | Apr. | May. | June. | July. | Aug. | Sept. | Oct. | Nov. | Dec. | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bourrel[1] .......... | 36 | 31 | 26 | 32 | 32 | 42 | 32 | 30 | 35 | 41 | 24 | 32 | 393 |
| Saint Cyr[2] .......... | 12 | 15 | 6 | 15 | 13 | 7 | 4 | 9 | 1 | 3 | ...... | 2 | 87 |
| Högyes[3] .......... | 309 | 310 | 314 | 367 | 450 | 502 | 580 | 537 | 455 | 438 | 303 | 396 | 4,961 |
| Leblanc[4] .......... | 103 | 97 | 121 | 192 | 155 | 138 | 147 | 123 | 104 | 117 | 95 | 100 | 1,492 |
| France:[5] | | | | | | | | | | | | | |
| 1895 .......... | 89 | 155 | 153 | 184 | 181 | 129 | 157 | 147 | 133 | 110 | 105 | 149 | 1,692 |
| 1896 .......... | 124 | 138 | 151 | 150 | 147 | 199 | 138 | 117 | 131 | 125 | 103 | 164 | 1,687 |
| 1897 .......... | 131 | 151 | 189 | 202 | 225 | 172 | 192 | 154 | 136 | 131 | 150 | 140 | 1,973 |
| 1898 .......... | 139 | 148 | ...... | 181 | 216 | 278 | 185 | 177 | 150 | ...... | 153 | 154 | 1,781 |
| Total ........ | 943 | 1,045 | 960 | 1,323 | 1,419 | 1,467 | 1,435 | 1,294 | 1,145 | 965 | 933 | 1,137 | 14,066 |

[1] Fleming: Rabies and Hydrophobia, London, 1872, p. 96.
[2] Loc. cit., p. 97.
[3] Högyes: Lyssa, Wien, 1897, p. 25.
[4] Leblanc: Statistique de la rage, Bul. de l'acad. de med., 1880, pp. 960–963.
[5] Official statistics.

These statistics are very interesting, and effectually dispose of the fallacy that rabies can not occur in the winter. The compilation of Bouley shows 755 rabid dogs in December, January, and February, and 788 in June, July, and August—a very slight difference, and one which is probably without significance. The records of the Alfort Veterinary School are of especial value, because the diagnosis was made by the most skillful experts in the world. These show two and one-half times as many cases in January, February, and March as in July, August, and September. Taking the compilation of 14,066 cases by months, it is found that June stands highest, with 1,467 cases, or about 25 per cent more than the average. July is second, with 22.4 per cent over the average. May is third, with 21 per cent over the average. It would appear, therefore, that the most cases of rabies occur during May, June, and July, which are not usually the hottest months of the year. If the heat has any considerable effect in the development of rabies we should expect August to show the largest number of cases; but, as will be seen by the table, it stands fifth in the list of months, with only 10.4 per cent more than the average, being below April, which has 12.8 above the average.

The fewest cases occurred in November, which month had 20.4 per cent less than the average; January had 19.5 per cent less than the average; March was 18 per cent below the average. As if to emphasize the uncertainty of predicting the distribution of rabies by seasons, according to the average temperature, February stands but 10.8 per cent below the average number of cases and December but 3 per cent below.

In a general way, it may be provisionally admitted that more rabies occurs in dogs in the months from April to September, inclusive, than from October to March; but the disease is seen in every month of the year, and as June stands highest, with 1,467 cases, and November lowest, with 933 cases, the difference is not sufficient to warrant any one in deciding that a suspected animal is not affected with rabies because the symptoms are observed in one of the winter months.

## THE SYMPTOMS OF RABIES.

The symptoms of rabies are such as we should expect from serious disease of the central organs of the nervous system: First, irritation; second, paralysis and death. The rabies virus appears to have little effect upon the system until it reaches the brain and spinal cord. There it multiplies, sets up irritation, and finally interrupts the functions.

Rabies is generally divided into two forms: First, furious rabies; second, dumb rabies. In the former the animal is irritable, aggressive, and bites nearly every object which comes in its way; in the latter the muscles of its jaw are paralyzed almost from the first appearance of symptoms, and being unable to bite, the animal remains more quiet and tranquil. Essentially the two forms of the disease are the same, but owing to the parts of the brain attacked and the acuteness of the attack, paralysis appears much sooner in one of these forms than in the other. The saliva from a case of dumb rabies is just as dangerous and virulent as that from a case of furious rabies. The dogs with dumb rabies are less dangerous simply because they are unable to bite and thus insert their saliva into a wound.

The impression should not be formed that dumb rabies and furious rabies always represent two distinct types of disease, and that one may at a glance classify every case as belonging to one or the other of these types. Quite the contrary. The typical cases belong to the two extremes of symptoms, and there are all gradations between the two. In fact, almost every case of furious rabies sooner or later changes into the dumb form, that is, the final stage of rabies is almost invariably paralytic, and the dumb form in its typical development occurs when the paralysis appears on the first day of the disease. The paralysis may not appear, however, until the second, or third, or some subsequent day.

Again, a dog does not necessarily bite everything about it even though it has rabies and its jaws are not paralyzed. It may be combative and furious all of the time, or only a part of the time, or not at all. There is no disease in which the symptoms vary more than in rabies of the dog, and it is, consequently, impossible in any description of moderate length to give an idea of the different forms under which it may appear.

### FURIOUS RABIES.

Fleming has well said that it is a great and dangerous error to suppose that the disease commences with signs of raging madness, and that the earliest phase of the malady is ushered in with fury and destruction. The symptoms appear very gradually, and at first there is only the slightest evidence of brain disease. The animal's habits and behavior are changed. It may be more restless and affectionate than usual, seeking to be near its master or mistress, fawning, licking the hands or face, and apparently seeking for sympathy or assistance. Such caresses are, however, extremely dangerous, for the animal's tongue, moist with virulent saliva, coming in contact with a part where the skin is thin, abraded, or wounded, may fatally infect the person for whom it is endeavoring to demonstrate its affection. The smallest abrasion may be, as Bouley has impressively said, a door opened to death; and such a death! The instances in which hydrophobia has developed from such inoculations are very numerous, and everyone should be warned against this kiss of affection, which carries with it not only death, but sufferings which are far more to be dreaded than the fatal termination.

In most cases dogs first become dull, gloomy, morose, taciturn, seeking solitude and isolation in out-of-the-way places, or retiring under pieces of furniture. But in this retirement they can not rest; they are uneasy and agitated; they lie down and assume the attitude of repose, but in a few minutes are up again walking hither and thither, "seeking rest, but finding none." Occasionally this restlessness may disappear for a time, and the animal become lively and affectionate; oftener it sinks into a sullen gloominess, from which even its master's voice rouses it but temporarily. It becomes more and more desperate in its efforts to prepare a comfortable bed, pawing or scattering the straw, or, if in a house, scratching, tumbling, and tearing cushions, rugs, curtains, carpets, and everything of that kind within its reach.

At this period dogs may have aberrations of the senses, of the sight, hearing, and feeling, which cause hallucinations, and lead them to think that they are being annoyed by something, or that some animal or person is endeavoring to injure them. They crouch, ready to spring upon an enemy; they rush forward and snap at the air; they throw themselves, howling and furious, against a wall, as though they heard sounds beyond it.

While at first the affected dog may not be disposed to bite, it becomes more dangerous as his hallucinations and delirium increase. The voice of the master or of an acquaintance may dispel the aberrations temporarily and lead him to friendly demonstrations, but an unexpected movement or touch may bring on another access and lead to a quick and unexpected bite.

The disturbance of the sensations leads to chills and itching. If the place where the bite occurred is accessible the dog licks the scar, and later bites and tears the tissues. This tearing of the flesh is not always confined to the site of the inoculation, but certain regions of the body appear to lose their sensitiveness, and at the same time to convey to the brain the sensation of itching. The animal in this case bites into its own flesh with apparent pleasure and satisfaction.

Such animals take food until the disease is considerably advanced, if it is something which can be swallowed without mastication; otherwise it is dropped after remaining a short time in the mouth.

Difficulty of swallowing is an early symptom, and frequently leads the unsuspecting owner to conclude that the animal has *a bone in his throat*. A dog which appears to have a bone in his throat is on general principles one of the most dangerous animals in existence. The supposed bone may be there, but on the other hand the symptoms which lead to this supposition may be due to partial paralysis caused by rabies, and the owner may be inoculated with the virulent saliva while thrusting his finger or hand in the dog's mouth to discover a bone which has no existence but in his imagination.

It is commonly believed that mad dogs have fear of water and are unable to drink, but there could be no greater mistake. In this respect they differ entirely from the human patient. They have no fear or dread of water, but continue to drink until paralysis has progressed so far that they are no longer able to swallow. The fact that a suspected dog is seen to drink or to wade into a stream is consequently no evidence that he is not mad.

When the furious symptoms come on, the dog leaves his home and goes upon a long chase, with no apparent object in view other than to be traveling onward. He trots at a rapid pace, eye haggard, tail depressed, indifferent to his surroundings. He flies at and bites dogs and persons whom he meets, but usually does not apparently search for them, or even notice them if they remain quiet. Dogs in this condition may travel many miles, and finally drop from exhaustion and die. Often after an absence of a day or two they return to their home, exhausted, emaciated, covered with dust and blood, and presenting a most forlorn and miserable appearance. Those who have pity for such an animal, and try to make it clean and comfortable, are in great danger of being bitten, for the disease has advanced to a point where the delirium or insanity is most marked, and where a treacherous bite is most common. Doubtless the dog has no intention of injuring a friend, and would not do so did he not see that friend transformed by his disordered vision into some distorted and unrecognizable shape, which he thinks is about to injure him. But while we may give the dog due credit for not intentionally and deliberately inoculating his friends with this fatal virus, let us not forget that the inoculation is no less deadly because it is the result of the abnormal working of a disordered mind. Whatever the sentiment may be which leads the dog to turn upon his master or mistress and inflict an injury, the duty remains the same for the owner to take due precautions to prevent such an occurrence.

If the animal, instead of being allowed to escape, is kept confined, the paroxysms of fury are seen to occur intermittently, or, in the absence of provocation, they may be entirely wanting. If excited, it howls, rushes upon objects that are thrust toward it, or throws itself against the bars of its cage and bites with great fury.

As death approaches, the animal becomes exhausted and scarcely able to stand; the eyes are dull and sunken, and the expression is that of pain and despair. Paralysis appears in the jaws or in the posterior extremities, and extends rapidly to other parts of the body. The animal, being unable to stand, lies extended upon its side; the respiration becomes more and more difficult; there are spasmodic contractions of certain groups of muscles, complete prostration, and death.

The ordinary course of the disease is four or five days; it may be as short as two or as long as ten days.

### DUMB RABIES.

When this form of the disease is typical, it comes on with restlessness, depression, a tendency to lick objects, and paralysis of the muscles, which close the jaws. As a consequence of the paralysis, the lower jaw drops, the animal is unable to close the mouth, the tongue hangs out, and an abundance of saliva escapes. The mucous membrane of the mouth becomes dry, discolored, and covered with dust. The animal remains quiet, does not respond to provocations, and appears to understand its helplessness. As Bouley has said, the animal can not bite and does not desire to bite.

When dumb rabies follows a period in which the animal has been affected with the furious form, the desire and tendency to bite may be retained even after the jaw is paralyzed.

The course of the disease is short, death usually occurring in from two to four days.

The dumb form of rabies is very common, and many persons know it as "drop jaw" who have no idea of its true nature.

Many of the common mistakes with reference to rabies arise from an imperfect knowledge of the symptoms. It is on this point that there is greatest need of educational work. Bouley has most earnestly warned us to "distrust a dog when it shows signs of illness; every sick dog should as a rule be suspected; more particularly distrust a dog when it becomes dull, morose, and seeks for solitude, which appears not to know where to rest, which is always on the move, prowling, snapping at the air, and suddenly barking at nothing when all around is perfectly still, whose countenance is somber, and only assumes its usual animated expression by brief starts; beware of the dog that seeks and scrapes incessantly, and exhibits aggressive movements against phantoms; and, finally, beware, above all, of the dog which has become too fond of you, and is continually endeavoring to lick the hands or face."[1] The writer would add to this warning the injunction to beware of the dog which appears to have a bone in his throat, and further beware of this animal when he has wandered from home and returns covered with dirt, exhausted and miserable.[2]

### THE PERIOD OF INCUBATION OF RABIES.

The period of incubation of a contagious disease is the time which elapses between the inoculation or exposure and the appearance of the first symptoms. With rabies this period varies remarkably. It may be as short as six or seven days, and it occasionally exceeds one hundred days. In rare cases, it has been reported on good authority that a year, or even fourteen months, elapsed between the time the animal was bitten and the time when the disease manifested itself. The majority of cases develop in from three to seven weeks.

During the greater part of the period of incubation the infected animal is healthy, and would not cause disease in any animal or person which it bites. The saliva may become virulent, however, two or three days before the appearance of the first symptoms, and any animal or person bitten after the contagion has contaminated the saliva is, of course, liable to contract the disease.

There is a very erroneous and rather stupid belief, quite common, to the effect that if a dog bites a person and becomes mad at any time thereafter the person so bitten will contract hydrophobia. This fallacy may have arisen from some instance in which a person had been bitten within a few days of the appearance of the symptoms of disease in the dog, and when the saliva was already virulent. However this may be, it is perfectly certain that a dog can not convey this disease when he does not have it or before he has himself contracted it. If, therefore, a dog does not show symptoms of rabies within a week from the time the bite is inflicted there is no danger of the person contracting the disease. The only possibility of an exception to this rule is the very doubtful one, that in extremely rare instances a dog may

[1] Fleming: Rabies and Hydrophobia, London, 1872, p. 197.

[2] In this description of rabies the writer has used as a basis the classical works of Bouley, Fleming, and Nocard and Leclainche.

have rabies and recover from it without showing characteristic symptoms. A very few cases of this kind have been observed among dogs artificially inoculated, but it has not been shown that their saliva became virulent, or that similar cases occur under natural conditions. The fact remains, however, that a person is in no danger of contracting rabies because a healthy dog has bitten him, which dog is afterwards inoculated with rabies.

The virus of this disease has been surrounded with so much mystery, and so many ridiculous opinions have been disseminated concerning it, that it is often looked upon with great awe and fear, as possessing either supernatural properties or at least being altogether different from anything else which has been known and investigated by scientific men. This is in no sense true, for while the rabies virus is peculiar to the disease and distinct from all other contagions and poisons, it is nevertheless subject to the same natural laws. If a person has sat in a crowded street car by the side of another person who some months afterwards contracts smallpox, the former would have no fear of the disease because he had been exposed to the latter before infection had occurred. On the same principle, no one would feel concerned because he had drank pure water from a clean cup, which cup was afterwards used as a receptacle for poisons. These illustrations are strictly germane to the subject, and should be sufficient to show the impossibility of the theory under consideration.

The extremely long period of incubation of rabies in certain cases is a fact which has been incontestably established.

Peuch has compiled a table of 144 cases of rabies in the dog in which the date of inoculation and the appearance of the first symptoms were definitely ascertained. These cases were observed by Renault, Leblanc, Saint-Cyr, and Peuch. This table is so instructive that it is reproduced from the Nouveau Dictionnaire de Médecine, de Chirurgie et d'Hygiène Vétérinaire, and the writer has added a column of percentages.

*Incubation of rabies in the dog.*

| Number of days of incubation. | Number of cases. | Per cent. | Number of days of incubation. | Number of cases. | Per cent. |
|---|---|---|---|---|---|
| 5 to 10 | 3 | 2.08 | 55 to 60 | 2 | 1.39 |
| 10 to 15 | 8 | 5.55 | 60 to 65 | 7 | 4.86 |
| 15 to 20 | 13 | 9.03 | 65 to 70 | 1 | .69 |
| 20 to 25 | 25 | 17.36 | 70 to 75 | 5 | 3.47 |
| 25 to 30 | 13 | 9.03 | 80 to 90 | 7 | 4.86 |
| 30 to 35 | 25 | 17.36 | 100 to 120 | 4 | 2.78 |
| 35 to 40 | 6 | 4.17 | 365 | 1 | .69 |
| 40 to 45 | 11 | 7.64 | Total | 144 | .......... |
| 45 to 50 | 9 | 6.25 | | | |
| 50 to 55 | 4 | 2.78 | | | |

Haubner mentions a case in which fourteen months elapsed after the bite before the disease developed. It is plain, therefore, that the rabies virus may retain its vitality and activity for a long time after it is deposited in the flesh of the animal body. How it can remain in the animal this length of time before it causes the disease is probably explained by the fact that it must reach the brain and spinal cord and multiply there before the disease develops. Now, the rabies virus is not able to penetrate through the body with the facility of many other forms of contagion; on the contrary, it appears necessary for it to be lodged in the circulating blood through a wounded vessel or to be deposited within the sheath of a nerve. If placed in the connective tissue beneath the skin in such manner as to avoid blood vessels and nerves it does not cause disease. In the cases of long incubation the virus has had difficulty in reaching the central organs of the nervous system.

Admitting, as we must, that a year may elapse between inoculation and the appearance of the disease, we must also accept the still rarer cases of fourteen months' incubation as not improbable. How absurd it is, therefore, to consider a bitten dog as safe after it has been quarantined for three or four weeks, as is the usual custom. Of the 144 cases carefully observed and brought together in the above table, 82, or 57 per cent, failed to develop the disease until after thirty days. A period of more than five weeks was required by 39.5 per cent of the animals, and 21.5 per cent showed no symptoms for seven weeks after being bitten. How long, then, should a dog that has been bitten by a rabid animal be quarantined before it is safe to mingle with the family and with other persons and animals? Is three months sufficient? Evidently not, for 3.47 per cent of this lot of dogs developed the disease after more than ninety days had passed. For absolute safety, every dog bitten by a rabid animal should be destroyed. For comparative safety a quarantine of one year is required.

### DOES RABIES ORIGINATE SPONTANEOUSLY?

Most of the older writers on rabies, those whose writings appeared before 1865, admitted that the disease might develop spontaneously in the bodies of certain animals as a result of certain conditions of life and atmospheric influences. These same writers believed that most other contagious diseases frequently originated in the same manner. It was a time when the spontaneous generation of many living things was freely admitted, and when the ignorance of the nature of all kinds of contagion, with the exception of the larger animal parasites, was complete and impenetrable. Science had not yet definitely passed upon the doctrine of the spontaneous and continuous generation of living matter.

It was not a very long time before this when it was believed that the mite which causes scabies or itch was continuously developed spontaneously, and that it was folly for people to try to protect themselves from this disease. About the same time, or possibly a little earlier, it was thought that lice were spontaneously developed, and that both the domesticated animals and mankind were doomed to suffer from them for all time. Still earlier there was a common belief that crocodiles and other animal life developed spontaneously from the mud of the rivers and lakes in which they were found.

The study of natural history and the progress of science disproved one by one these ancient beliefs, and made it clear that all animals developed from preexisting animals of the same kind. Even lice and the mites of scabies were found to be subject to this invariable law of nature, and the eradication of such pests was taken up with energy and perseverance. The rarity with which these parasitic pests are encountered among civilized people of the present day proves the value of correct views upon such questions.

The last point to be yielded by the believers in spontaneous generation was the origin of the protozoa and bacteria, microscopic animals and plants so small that their life history could be studied only with great difficulty. It was finally shown, however, that even these infinitely small organisms obeyed the general law of nature and propagated and developed from ancestors, each species after its kind, and that in the absence of ancestors not even these low forms of life could appear.

About this time it began to be suspected that the cause of the contagious fevers was microscopic organisms, which were able to live a parasitic life in the bodies of men and the larger animals. After many observations pointing in that direction it was finally demonstrated in 1876 that the cause of anthrax was a bacillus, and shortly afterwards that fowl cholera, septicæmia, hog cholera, tetanus, blackleg, tuberculosis, and various other diseases were due to similar microscopic vegetable organisms, each disease being caused by its own distinct species of germs. It was also shown that malaria, Texas fever, and some other diseases were caused by microscopic animal organisms belonging to the protozoa, and that here again each disease had its own definite and distinct species. In every case the minute plant or animal parasite had its own definite form and certain biological characters by which it might be distinguished from all other living things. Each species multiplies and propagates its kind, and there is no more evidence here than elsewhere in nature to sustain the doctrine of the spontaneous appearance of living things.

The first effect of these scientific demonstrations was to clear away a vast amount of rubbish which had accumulated in the standard teachings as to the cause of contagious diseases. If, for example, anthrax is caused by the *Bacillus anthracis* gaining entrance to the interior of the body and multiplying there, and if the disease can not be produced in the absence of this bacillus, then it becomes plain that the disease is not caused by electrical disturbances of the atmosphere, by too much food or too little food, by forage containing too much water or that which is too dry, by intense heat of summers or extreme cold of winters, or indeed by any of the other influences to which the development of the disease had been usually attributed. It was contact with substances containing the bacillus which produced the disease, and when this bacillus gained access to the animal body the disease developed without reference to the atmospheric conditions, the food, or the other elements of the environment.

The comprehension of this fact led Bouley and other great pathologists to revise their opinions regarding the origin of many contagious diseases. It had been held that glanders originated spontaneously from overwork and insufficient food; that bovine pleuropneumonia developed as a result of exposure of cattle in the mountains of Europe to extremely low temperatures; that cattle plague arose spontaneously in eastern Europe, and particularly on the steppes of Russia, and that rabies in the dog resulted from unfavorable conditions of life. The demonstration of the germ theory of contagion, which was quite unexpected by the majority of medical men, completely overturned these old views, based upon an entirely different hypothesis. The idea of spontaneous development, of origin *de novo*, was generally abandoned, and the further scientific researches have been pushed, the more incontestible does it appear that the one and only factor of consequence in the production of these diseases is the entrance of the disease germ into the interior of the animal body, where it can multiply and disseminate itself.

If proper measures are taken to protect animals from the bacilli of anthrax, of glanders, of pleuropneumonia, they do not contract these diseases. Investigation of cattle plague in central Europe indicated that the disease always came from the East. Investigations on the steppes of Russia showed that it did not originate there, but came from the plains of Asia. Investigations in Asia indicate that even there the disease is always the result of contagion from some other affected animal. In the same manner, investigations of rabies failed to bring out any evidence to indicate that the disease might originate in any way except by contagion, that is, by inoculation from an affected animal. It may, therefore, be accepted as practically certain that rabies does not develop spontaneously in any animal, but that it is always the result of inoculation from some other affected animal.

If the doctrine of spontaneous generation, or abiogenesis, has been abandoned by scientific men, it has by no means lost caste with many persons who consider themselves philosophers; and these persons hesitate to accept or indeed bitterly contest the conclusion of science, which has been outlined above. If, they ask, every dog with rabies contracted the disease from some other dog affected with it, how did the first dog get it? This is a question as to the origin of things, which we may with equal reason ask in regard to all living organisms. If every dog is brought into the world by the sexual union of two other dogs, where did the first dog come from? This question is just as difficult, but no more difficult than the other. Because we have in our question implied the philosophical absurdity of a series of dogs without a beginning, we have not convinced anyone that dogs can originate in any manner except by ancestors of their own species; nor is the similar question as to the origin of the first case of rabies any better reason for accepting the theory of the spontaneous origin at the present day of this disease.

There are many diseases of which it may be said that in our time and in our country they arise only by contagion. Prominent among these are smallpox, scarlet fever, measles, cholera, tuberculosis, glanders, bovine pleuropneumonia, foot-and-mouth disease, and rabies. Recorded history does not tell us where and under what circumstances the first case of any of these diseases appeared, any more than it tells us where and under what circumstances the first dog appeared. We know by observation, and by observation alone, how dogs are propagated at the present day, and we accept observation as conclusive upon this point. Why should we not accept observation and experimentation as conclusive in regard to the propagation of a contagious disease?

While we can not reasonably expect at this late day to decide the cause of contagious diseases by speculation as to the first appearance among animals of such diseases, it is legitimate to make such an inquiry in order to obtain a better understanding of these plagues. Science has made great progress in explaining the origin of species, and even in tracing in general terms the development of life upon earth; and while it can not say definitely where, when, and how the dog originated, it has been made plain that in some prehistoric age the dog developed from some earlier and related animal form, not by a sudden transformation, but by gradual transition. And in the same manner this early ancestor of the dog developed from a still earlier ancestor, doubtless quite different from the dog as he is to-day. To be brief, in tracing the development of the dog, we should be obliged to go back, step by step, toward the dawn of creation, toward simpler and simpler forms of life, until the primordial germ is reached. Just where in this long series of succeeding forms or just when in the countless ages that have elapsed since the beginning of the series the disease known as rabies appeared it is impossible to say. It may have been in comparatively recent times, and when the dog had arrived at substantially its present form and development, or it may have been in some previous geologic age, when the conditions of environment upon all parts of the earth were far different from what they are at the present day.

It is not to be supposed that the strange animals whose fossil remains prove their existence many thousands of years ago were free from contagious diseases any more than are the animals which live to-day; but whether the diseases of the prehistoric animal species were propagated from animal to animal until our time, or whether they disappeared and were replaced by more recent plagues, it is now impossible to say.

A study of the communicable diseases indicates that most if not all of them are caused by parasitic organisms. Indeed, the animal body has become the host of a multitude of parasites, most astonishing because of the number of species and the great variety of forms. All of these parasites probably at one time in the existence of their species, or of the ancestors of their species, lived elsewhere in nature. Under certain conditions they were attracted to certain kinds of animals; they found they could live upon or within them; they adapted themselves to these new conditions; their form and their physiological requirements were gradually changed, until finally in the course of time they could not exist elsewhere. They were then strictly parasitic.

So far has this development and adaptation to the conditions of environment gone that we find different species and varieties of lice, of mites, and of worms living upon each different species of animals, and in most cases these parasites perish if transferred from one species of animals to another species. If, therefore, these parasites can not exist when transferred to a different species of animals from that upon which they have developed and to which they have become adapted, there is all the more reason why they can not exist in nature elsewhere than upon or within the animal body. Hence, we find animal species living as parasites upon other animals, and having no individuals of their species living a nonparasitic existence. They have developed and have been modified since they began their existence as parasites, just as the species of animals living free in nature have been modified. Consequently, if an animal becomes infected with lice or mites at the present day it must get them from some other animal which bears them.

The adaptation and modification of the bacteria and protozoa which cause the contagious diseases has probably occurred in much the same manner as that of the larger animal parasites which we have been considering. The glanders bacillus has lived a parasitic existence in the bodies of animals of the horse kind for many thousands of years. It is no longer able to multiply or live for any considerable time in nature outside of the animal body. It is therefore a strictly parasitic organism. The bacillus of tuberculosis is even further developed as a parasite than the bacillus of glanders, as it is much more difficult to cultivate in the laboratory even under the most carefully adjusted conditions.

There is no reason to suppose that any bacilli exist in nature having the same biological characteristics as have the glanders and tuberculosis bacilli.

The exact form of the rabies virus has never been satisfactorily determined, but what we know of it leads to the conclusion that it is a parasitic organism of some kind, which has been modified by thousands of years of existence within the animal body, and which has no counterpart elsewhere in nature. Inoculation with it is easy; it has specialized as to the conditions of life to such an extent that it multiplies only in the brain, spinal cord, nerve trunks, and a few glands; it can not be made to grow outside of the body by any methods now known. All of these facts indicate an obligatory parasitic existence. When or under what conditions in the prehistoric ages of the past it first became parasitic can never be known, nor can we determine at this late day how long a time was required to transform it from an organism which was only occasionally or accidentally parasitic into one which could live no other than a parasitic life. What appears certain is that for more than two thousand years rabies has been the same disease it is to-day; that it has been propagated by the same species of animals, manifested itself by the same symptoms, and produced the same fatal results.

It is not unlikely that other microscopic organisms will from time to time take up their habitat in the animal body and become obligatory parasites. There are a number of different bacilli now known which are capable of living in the flesh and causing fatal disease, but which only do this under accidental conditions. Among these are the anthrax bacillus, the bacillus of blackleg, the bacillus of malignant œdema, and the bacillus of tetanus, all of which are deadly in their effects on animals inoculated with them, but all of which lack some quality required for their rapid dissemination or for the ready infection of susceptible animals. Consequently, they do not usually spread from animal to animal. With slight modification the anthrax bacillus might become the most terrible of the known disease germs. But that such modifications require time and conditions not often found, is proved by the fact that though this disease has been known since the beginning of medical knowledge, the bacillus has in the memory of man made no progress as a disease-producing organism, but on the contrary appears less capable to-day of gaining entrance to the tissues than it was two or three centuries ago.

## THE PREVENTION OF RABIES.

It is unfortunate and inconsistent that those who pretend to love dogs most and to be most anxious for their welfare should be the ones who place the greatest obstacles in the way of attempts to control this disease. Of all animals, the dog is most often the victim of rabies, and he suffers not only from the disease, but from the reputation of propagating it. And to make the matter worse, he is still falsely accused of being a party to the spontaneous generation of the contagion. His true friends should come to the rescue and relieve him of this incubus, which he has borne so long.

There is no contagious disease more easily eradicated than rabies. As the disease can only arise from contagion, and as the contagion is practically always transferred by a bite, and as the animals which do the biting are almost always dogs, it suffices to stop the dogs from biting for a period sufficient to cover the incubatory stage of the disease, that is, for about a year, in order to stamp out the malady. As a scientific problem, therefore, the eradication of rabies is a very simple matter, but as a practical question it is one of the most difficult which confronts the sanitarian. And this difficulty arises not from anything inherent in the work to be accomplished, but in the opposition of those who own and keep dogs. The measures necessary for the eradication of rabies are two in number: (1) Destruction of worthless, ownerless, and vagrant dogs; (2) efficient muzzling of all dogs which appear upon the streets or in public places.

The dog tax and license are efficient means of securing the destruction of worthless dogs, and if these are combined with the requirement that every licensed dog shall wear a metal tag of special form, the ownerless and vagrant dogs may be at once recognized and captured. As more than half of the dogs in the country are worthless or ownerless, this measure at once reduces very largely the canine population, and correspondingly lessens the material upon which the disease can work, as well as the chances of infection.

An efficient muzzle prevents dogs from biting, and, therefore, prevents the propagation of rabies. Muzzling is for this reason the most effective measure with which to combat the disease. Public sentiment in this country is generally against muzzling, and this measure is either not adopted or it is so imperfectly enforced as to have no other effect than to irritate the supersensitive dog owners. In Germany and Great Britain muzzling has had an immediate and most marked effect in eradicating the contagion.

The effect of these measures depends entirely upon the energy and thoroughness with which they are enforced. There should be a dog-catching force adequate to the work, whose duty it should be to seize all dogs found in public places without tags and all dogs wearing inefficient muzzles, and if these animals are not redeemed within a specified time to destroy them. Usually the requirements for tags and muzzles are evaded by a large number of dog owners, and it is common to see on the streets of cities, where they are supposed to be in force, numerous dogs without tags, and even a greater number with muzzles that are of no value as a means of preventing the animal from biting. This is due to the fact that there is seldom a sufficient force of dog catchers, and that the sympathy of the community is with those who violate the law rather than with those who endeavor to enforce it.

When there is an unusual prevalence of rabies among dogs, or when, unfortunately, some person contracts the disease, particularly if that person happens to be well known or prominent in the community, there may be a temporary exhibition of strict and energetic enforcement of the regulations. But as soon as the public alarm subsides the efforts are relaxed, the dog catcher disappears, the dogs are seen upon the streets with or without tags and muzzles, and all things go on as before the panic occurred. While the number of dogs is thus periodically reduced somewhat, it is seldom that this reduction is sufficient to have much effect upon the propagation of the disease. It is probable that the tendency at such times to keep dogs confined in order to prevent them from being seized has more influence in arresting the propagation of rabies than has the mere reduction in numbers.

In nearly all cases when reliance has been placed upon the one measure of reducing the canine population the result has been unsatisfactory. What other disease would we attempt to stamp out by simply killing off one-fourth or one-third of the animals of the species affected? And if this measure is not efficient with other diseases, why should we expect it to be with rabies? It appears self-evident from a sanitary point of view that there should be some direct measures instituted to prevent the propagation of the contagion. Such a measure would be the quarantine and confinement of all dogs for a sufficient time to cover the ordinary incubation period of rabies. As the enforced and continuous confinement of dogs without open-air exercise for a prolonged period may be detrimental to the animals, they may be allowed in public places under such conditions as will absolutely prevent them from biting, that is, the animals should wear an efficient muzzle, or they should be muzzled and led in leash. As rabies is only propagated in nature by biting, such a regulation, if thoroughly enforced, would at once stop the transmission of the disease and soon lead to its disappearance. When this measure is inaugurated, however, it is at once opposed by a large class of citizens who hold it to be cruel and unnecessary. Some muzzles are unquestionably cruel, but a properly made muzzle is not cruel, nor does it greatly inconvenience the dog after he becomes accustomed to it. The authorities should, therefore, prescribe the kind of muzzle to be used, and should select one which covers the mouth with a wire cage so as to prevent biting without interfering with the movements of the jaw and the ingestion of liquids.

There have been many who have denied the utility of the muzzle, the strongest argument being that dogs do not wear it at home, and when they develop rabies and escape it is always when they are unmuzzled. Admitting the force of this argument, it is nevertheless a fact that if all dogs were required to be muzzled when in public places, the appearance of a dog without a muzzle would at once attract attention, leading persons to avoid it and causing its early seizure by the authorities. Children might be instructed that an unmuzzled dog was dangerous and that they should keep at a distance from it, and especially that they should never touch or fondle such an animal.

The results which have been obtained by muzzling justify its enforcement wherever there is an outbreak of rabies. Most of us have heard of the experience of Berlin with this measure about the middle of the century. From 1845 to 1853 there were received at the Berlin Veterinary School 278 rabid animals. This is an average of 35 a year. From March, 1852, to the same month in 1853 the number was 82, and from March, 1853, to the end of July there were 37 more. On July 20 it was ordered that the use of the muzzle should become general. From July to the close of the year but 6 cases were admitted. Only 4 cases were observed in the whole city during 1854, and but a single case in 1855. For the seven years following there was not a single case recorded.[1]

While some have attributed the disappearance of rabies from Berlin at the time mentioned to other causes, muzzling has been adopted in Germany as the principal reliance in repressing this disease. It appears that the number of cases of rabies in Berlin increased progressively after 1863, until in 1868 it reached 66, declining again to 7 in 1870, only to increase in 1872 to 69. In 1875 a law was passed, extending to the whole of Prussia, which provides that all dogs suspected of rabies shall be immediately killed, as also all animals which it is evident have been bitten by rabid animals, and that all dogs in a district which has been infected by an outbreak of rabies shall be confined, or, when abroad, both muzzled and led. The technical section of the veterinary board in Berlin are of the opinion that the passing of this law, and not alone the existence of the muzzling order in that city, is the cause of the extinction of rabies in Berlin. No case has occurred there since 1883.[2]

Consul-General Mason reports from Berlin to the State Department that "in Berlin, Frankfort, and, so far as I know or can ascertain, in all cities and large towns in Germany, dogs are required to be muzzled whenever they are on the street or public place, and this regulation is enforced in cities even when the dog is led or held in leash by the owner, or is harnessed for working purposes to a cart or other vehicle."[3]

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[1] Renault, cited by Bouley, in Rapport sur la Rage, Bul. de l'Acad. de Med., Paris, 1863, p. 725. Fleming: Rabies and Hydrophobia, p. 365.

[2] Fleming: Paper read before the Seventh International Congress of Hygiene and Demography, London, 1891.

[3] Consular Reports, June 19, 1900.

Fleming states that "in Vienna rabies was entirely suppressed by eighteen months of stringent muzzling, but that in 1886 the muzzling order was rescinded and badges had to be worn on dog collars instead; in the following half year there was only one case of the disease, but in the next half year rabies became epidemic, and the muzzle had again to be worn, with the result that the malady soon subsided and disappeared."

In Holland, before 1875, rabies was prevalent to a very serious extent, but in June of that year the use of the muzzle was ordered, with the result that in the autumn the number of cases fell to 41; in the next whole year there were 55 cases; in 1877 there were 14; in 1878 there were 4, and in 1879 there were 3. These, and the cases which have since been reported, occurred only on or near the frontier of Belgium, in which country the muzzle is not in use, though rabies is always prevalent.

In the Grand Duchy of Baden during the years 1871, 1872, 1873, 1874, and 1875 the number of cases of rabies was, respectively, 18, 37, 37, 50, and 43. Then the muzzle was rigorously applied, and in 1876 there were 28 cases; in 1877, 3; in 1878, 4; in 1879, 2; in 1880, 2; in 1881, 2; in 1882, 3; in 1883, 2; in 1884, 2. Since that year only 1 case has been observed, and that was a dog from Metz contaminated before its arrival in Baden.

In Sweden rabies was at one time a somewhat common disease, and from 8 to 10 people died annually of hydrophobia; but, muzzling being enforced, and the importation of dogs prevented, rabies has been unknown for many years, and no deaths from hydrophobia have occurred since 1870.

The value of the muzzle in suppressing rabies has been perhaps best demonstrated in London on several occasions, and specially in 1885. In the previous years hydrophobia had increased to a very alarming extent in England, and no steps worthy of note had been taken to check the mortality. For London alone in that year no fewer than 27 deaths were reported as due to the bites of rabid dogs. A muzzling order was then enforced, and at the end of 1886 not a death was recorded. Unfortunately, the order prescribing the use of the muzzle was then rescinded, and in a few months a case of hydrophobia occurred in the south of London, soon to be followed by others, and in 1889, 10 deaths were registered. In July of that year the muzzling order was again issued and stringently carried out, and rabies and hydrophobia once more disappeared.[1]

In the whole of Great Britain the results from enforcing the muzzling order have been phenomenal, both in the opposition encountered

[1] Fleming: Paper before Seventh International Congress of Hygiene and Demography, 1891, quoted by committee on public health of the Medical Society of the District of Columbia, Bul. No. 25, Bureau Animal Industry.

by the authorities and in the successful eradication of the disease. The number of rabid dogs officially reported was, in 1887, 217; 1888, 160; 1889, 312. In the last-mentioned year muzzling was adopted, and the number of cases fell to 129 in 1890, 79 in 1891, and 38 in 1892. Then, owing to persistent opposition, muzzling was stopped, and the effect of withdrawing this measure was at once seen in the increase of rabies. In 1893 there were 93 cases; in 1894, 248, and in 1895, 672. At this point, owing to public alarm, muzzling was again enforced, reducing the number of cases in 1896 to 438, in 1897 to 151, in 1898 to 17, in 1899 to 9. As no case was discovered from November, 1899, to March, 1900, it was believed by the veterinary officer that the disease had been extinguished from Great Britain.

These examples are certainly sufficient to demonstrate the value of muzzling as a means of repressing rabies, and it may be added that in countries like France and Belgium, where muzzling has not been adopted, the disease continues to prevail to a very serious degree.

# THE SCALE INSECT AND MITE ENEMIES OF CITRUS TREES.[1]

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## Introduction.

Any consideration of the insect enemies of citrus plants must give large importance to the scale insects, or bark lice, which are not only very destructive on the orange and lemon and other citrus fruits, but are also the chief insect enemies of most other tropical and subtropical plants.

Scale insects are, as a rule, small and inconspicuous singly, but they multiply so rapidly that very soon an entire plant becomes infested—trunk, limbs, leaves, and fruit. The infested tree is rarely killed outright, but its growth may be almost completely checked and its fruit products rendered valueless.

Next in importance to the scale insects are the mite enemies of the orange and lemon, as represented by the mite which causes the rusting of the orange in Florida and the silvering of the lemon in California, and also the leaf mite, known from its coloring as the six-spotted mite of the orange. These mites, occurring along with the scale insects and being subject to similar remedies, may properly be considered in the same connection.

Of very great importance to the Florida grower of citrus fruits is the so-called white fly, the latter not representing a scale insect in its

[1] No one can discuss the insect enemies of citrus plants without acknowledging indebtedness, as the writer now does most heartily, to the very comprehensive and valuable work on this subject prepared by the late H. G. Hubbard and published by this Department in 1885, and which for many years has been the chief authority on the subject covered. One is struck to-day, fifteen years after its publication, with the sound, practical ideas contained in it, particularly on the subject of the control of the scale and other insects treated. Mr. Hubbard was a successful orange grower in Florida, as well as a thoroughly trained scientific man, and one of the closest observers of insects this country has produced. The practical side of Mr. Hubbard's work is especially to be remembered also, because he was the deviser of the kerosene-soap emulsion, which, with allied washes, has for many years been the leading means of controlling scale insects. His work, entitled "Insects affecting the orange," but really covering the whole subject of citrus insects, having long been out of print, Mr. Hubbard was, just prior to his unfortunate illness and death, collecting data for a new edition, to be published by the Department. It will be a source of lasting regret that he was not able to accomplish this undertaking.

ordinary acceptation, but in the practical features of life history and habits coming in the same category, and hence properly considered with the true scale insects.

There are a great many insect enemies of citrus plants other than the scale insects and mites, but, for this country, at least, these others, in the main, have no great economic importance, or are only very occasionally abundant enough to be especially destructive. In this category are the various leaf-feeding insects and some wood-boring species. At rare intervals some of these leaf-feeding species appear in numbers sufficient to defoliate trees more or less completely, or wood-borers may attack and hasten the death of frost-injured or otherwise weakened trees; but none of these insects calls for the constant attention and treatment which is necessary to prevent annual loss from scale insects.

Occurring about the orange and other citrus trees will be seen also a great many other insects which play a beneficial rôle, preying upon or parasitizing the scale insects living on these trees. It is very important to make the acquaintance of these beneficial species, more particularly to avoid, whenever possible, killing them in the warfare waged against the injurious ones.

## Some General Considerations Bearing on Citrus Insects.

Before taking up the consideration of the several species to be treated in this paper some general topics may be discussed, such as the influences which determine the destructiveness of these insects, the species characteristic of different regions, and the nature of the injury occasioned by them, natural enemies, remedies, and means of control.

### INFLUENCE OF CULTIVATION, PRUNING, AND CLIMATE.

It is just as true in the case of the orange and lemon as it is with other plants that negligent cultivation and improper care, or any unfavorable conditions of climate which weaken the vitality and vigor of the tree, encourage the presence and multiplication of the insect enemies. On the other hand, there is something in the vigor of growth and condition of the sap of a healthy tree, living under the best conditions, which is repellant to insect attack; and it will be almost invariably found that the unhealthy tree is the one first severely infested with scale insects or mites. This does not mean that vigorous, healthy trees will not be attacked, but on such trees insects seem to be less apt to multiply abundantly and effect the complete investment that is often noted in the case of a weak or improperly nourished plant. Therefore, as a means of protection against scale insects, a proper system of cultivation and pruning is highly important.

The value of pruning as a means of preventing scale-insect injury can not be too strongly urged. Scale insects thrive best where they are protected from direct sunlight and free movement of the air, hence trees of dense growth, unpruned, are almost certain to have their centers, at least, scaly. A well-opened and pruned tree, in which free access is given to light and air, is much less apt to be badly attacked than a dense, thick-headed tree, the interior of which is entirely shaded and protected and the moisture held, thus furnishing the conditions most favorable for the well-being of scale insects. As a general proposition, therefore, light, air, and dryness are inimical to scale insects, and, conversely, shade and dense habit of growth, protecting from air currents and holding moisture, are favorable.

The truth of this is often exhibited in the citrus districts of the Pacific coast. Very frequently the high temperature and dryness of the long summers, if allowed to have full action on well-opened and pruned trees, is as destructive to scale insects as would be a thorough treatment with an insecticide, in some cases killing the scales out almost completely. Similarly, scale insects are more apt to be abundant and troublesome in moist, warm regions than in regions with even higher temperature, but with a very much lower rate of humidity. In general, therefore, the citrus orchards in Florida, Jamaica, and the West Indies suffer more than do those in California. On the Pacific coast, also, the orchards in moist ocean districts are much more apt to be infested than those farther inland with greater elevation and enjoying a lower degree of humidity, with occasional much higher summer temperatures. The black scale in California has, in places, been almost entirely exterminated by the temperature holding for several days above 100° F., and a similar effect is noted with other species also.

### PERIODICITY IN SCALE INSECTS.

With most insects injurious to cultivated plants a periodicity is noted in their occurrence in injurious numbers. In the case of subtropical species, like the scale insects affecting citrus plants, this periodicity is not always as marked as it is with insects affecting deciduous plants and field crops in temperate latitudes. While it is true that scale insects have always occurred more or less on citrus trees in the Old World and wherever these plants are cultivated, investigation will undoubtedly show that there have been more or less well-marked periods of destructive abundance separated by periods of comparative scarcity. In illustration of this may be noted the epidemic referred to by Hubbard as prevailing throughout the entire orange, lemon, and olive districts along the shores of the Mediterranean from Italy to Spain during the first decade of the present century, to the consternation of the inhabitants, who were dependent upon these fruits. This unusual scale epidemic subsided, however, and very largely of itself, efficient remedies at that date being practically unknown.

In the same way in this country, scale infestation varies considerably from year to year. The fluted scale, in California, increased enormously during the first ten or fifteen years and threatened the very existence of the citrus cultures. Thanks, however, to the Australian ladybird, and, doubtless also, to the fact that many native predaceous and parasitic insects became acquainted with it, it is no longer feared in California. The long scale in Florida, also, was much more injurious in the first years of its activity than it has been since. In 1896 the black scale was very abundant and destructive in the orange districts about Riverside. Partly owing to adverse climatic conditions and partly owing also to natural enemies, this insect has almost disappeared from this district, which is now one of the least affected by scale insects.

These facts are merely cited to give the citrus grower whatever encouragement they may offer, but not in the least with the idea of belittling for an instant the need of remedial operations for the prompt and immediate control of scale insects whenever and wherever they appear. While, therefore, we may reasonably anticipate the necessity of yearly control of one sort or another, we may yet hope that any unusual abundance, perhaps exceeding our efforts at control, may not necessarily represent a permanent, but rather a temporary condition.

### SPECIES CHARACTERISTIC OF FLORIDA AND THE PACIFIC COAST, RESPECTIVELY.

The culture of citrus fruits in this country, limited as it is in the main to two widely separated localities, Florida and the Gulf region on the one hand, and the Pacific coast region on the other, has presented in the past, perhaps more than at present, a distinct variation for the two regions in the character of the scale and other insect enemies. This is very naturally to be expected in view of the difference in climatic conditions exhibited by these two regions, one having practically a desert climate with scant rains in winter, depending almost entirely on irrigation, and the other a very moist climate with frequent rainfalls and a very high rate of humidity.

Until recent years, the scale insect enemies of distinct importance in California have been limited to very few species, notably the black scale and the California red scale, together with the so-called "yellow" variety of the latter, and, prior to the introduction of the Australian ladybird, the fluted scale.

In Florida and the Gulf districts the species of greatest importance are the long and purple scales, the Florida red scale, the chaff scale, and the white fly, the latter, as already explained, closely resembling but not representing a true scale insect. The rust mite and the six-spotted mite, long known in Florida only, have in recent years been carried to California, and are slowly invading the southern citrus districts of that State. The other insect enemies of the orange and lemon, also formerly characteristic of one or the other of these two regions, are rapidly becoming common to both, although in point of injurious abundance the distinction between the two regions still, in the main, holds. The black scale occurs in Florida but is not troublesome at all, and the California red scale has not, apparently, been able to establish itself in Florida, but is very troublesome on some of the West Indian islands. The fluted scale, introduced in one locality in Florida in 1893, has spread locally very slowly, not appearing elsewhere so far as known. On the other hand, the distinctive Florida scales have all been taken to California and are slowly establishing themselves, but so far have not assumed the injurious rôle in California which they play in Florida.

## NATURE OF THE INJURY OCCASIONED BY SCALE INSECTS.

The damage occasioned by scale insects is of two kinds. The first and principal injury is the extraction of the juices of the plant, the scale insect in its relation to its food plant being a mere pumping machine, which is continually absorbing the sap from its host. In a general way the scale insect is a mere sack with sucking mouth parts, the latter consisting of a long, slender proboscis, or beak, which is thrust deeply into whatever portion of the plant the insect may be resting upon—bark, leaf, or fruit. While the amount of sap extracted by a single insect is very small, when multiplied by millions it greatly depletes the juices of the plant. Very often the amount taken up by the scale insect is greatly in excess of its own needs, and is excreted in the form of the so-called "honeydew," which accumulates in drops and spreads out over the bark or leaf in the form of a sticky liquid. This liquid attracts ants in great numbers, which very often gives rise to the belief that the ants are depredating on the plant, instead of, as the fact is, merely being attracted by the honeydew, which they are actively collecting.

The second form of injury caused by scale insects results largely from this honeydew excretion, which not only spreads over the leaves and fruit and prevents the normal respiration of the leaves and the development of the plant, but a black fungus develops in the sweetish liquid and ultimately thickly covers the leaves, twigs, and fruit, still further stifling the plant and reducing the marketable value of its products. It very often happens, therefore, that the grower is more anxious to avoid the presence of this fungus which follows the scale insect attack than the injury by the scale insect itself.

Associated with the damage due to the absorption of the juices of the plant by the scale insect is very often a poisoning of the plant itself caused by the irritation excited by the beak of the insect or by some liquid injected by the beak. In the case of the orange, lemon, and other citrus fruits, this injury is not so apparent as it is with the scale insects attacking deciduous plants, but it undoubtedly occurs with citrus plants, to some extent, at least.

Another reason for the extreme injury wrought by the scale insects arises from the fact that they are active the whole year round in climates where citrus trees can be grown. Their greatest activity and most rapid breeding period is during the summer months, and especially from May to August, or with very little check until October or November. In the winter season, or rainy season, they are more dormant and, while breeding continues to a greater or less extent, it is at a very much lessened rate.

### THE NATURAL ENEMIES OF THE CITRUS SCALE INSECTS.

Attention has already been drawn to the great desirability of protecting and encouraging the natural enemies of scale insects. The natural predaceous enemies of scale insects of greatest importance are various species of ladybirds, as illustrated by the Australian ladybirds, imported to control the fluted and black scales, and a great many native species, which are very effective agents in the control of these and other scale insects. The work of ladybirds is especially important against the young of the armored scale and against the softer and freely-moving scale insects which secrete no protective covering. Whenever, therefore, ladybirds of any species are found to be abundant on any scale-covered tree, they may be safely recognized as friends and working in the interest of the grower. If they are very abundant, indeed, it may be even unwise to fumigate or spray. The black scale has been completely controlled on certain ranches in California by its imported ladybird enemy, and this control has been brought about by the entire cessation of all insecticide operations. Most of our ladybirds, however, will probably stand a spraying without being killed, and, as a rule, it is hardly worth while to take the chance of loss to the fruit while waiting for the ladybird enemies to do their work. The experience, however, on the Cooper ranch and at other localities in California has certainly demonstrated the advantage of giving the ladybird enemies a fair chance. Those interested in this subject should consult the article on "Insect control in California," by the writer, published in the Yearbook of this Department for 1896, and also the portions of the present paper relating to the black and the fluted scale.

The other important class of enemies of scale insects are the hymenopterous parasites. The recognition of these friends is not so easy as that of the ladybirds, and, as a rule, they will probably escape detection. If one finds that the black scale or the armored scales are pierced with minute round holes, it is a safe indication that they have been parasitized, and that the parasites have escaped and are multiplying in the younger scale insects on the trees, and here again if the parasitism is found to be general, it may be inadvisable to spray or fumigate.

The other natural enemies of scale insects are not so important as those mentioned; still they are of service, and should be recognized. These include the larvæ of the lace-winged flies (*Chrysopa* spp.), which feed on the young of both the armored and the unarmored scales. There are also a few dipterous, or fly, parasites of scale insects, and the larvæ of several species of Lepidoptera are carnivorous and feed on the larger species of scale insects, such as the Lecaniums and wax scales. The latter are sometimes abundant enough to afford a very considerable check on the multiplication of the species of scale insects attacked. The various species of ants which are usually abundantly associated with scale insects on trees, and which are very often supposed to be preying upon the scale insects, have no beneficial action in this direction whatever. They are attracted to the trees, as already noted, by the honeydew secreted by the scale insects, and their rôle, if worth considering at all, is an unfriendly one, since they are a means of conveying the young scales which may attach to their legs or bodies from one plant to another.

A most desirable outcome would be to secure a complete and practical control of scale insects by their natural enemies, and the immense benefit which would accrue to the people of this country if it were possible to control all scale insects as the fluted scale has been controlled, will be at once apparent. The conditions, however, in the case of the fluted scale were exceptional, and have not been duplicated in the case of any other scale insect; even in the case of the black scale the control has been complete only in a few instances, although its imported ladybird enemy has been distributed in enormous numbers throughout southern California. Spraying and fumigation, therefore, must be relied upon for some time to come, or at least until the natural enemies have been more fully studied, and better means of successfully colonizing them devised. Climatic conditions also affect the activity of these natural enemies to such an extent that the same results can never be counted on in different localities.

In considering the agency of control afforded by the natural enemies of scale insects, the fact must not be lost sight of that these predaceous and parasitic enemies are dependent on the scale insects for their existence, and that therefore a fairly complete extermination of the host insects means a like extermination of its parasitic or predaceous enemies. There is, therefore, a natural alternation or periodicity in the abundance of the scale insect and its parasites. An almost complete extermination of the scale by the parasite means, ultimately, a very great scarcity of the parasite, which gives the scale insect a chance to slowly reappear in increasing numbers. This is followed again by the recurrence of the parasite in great numbers, and the host insect in turn disappears once more. If reliance be made solely on the predaceous and parasitic insects, therefore, this periodicity in the occurrence of the scale must be counted on. Theoretically, it is true that such recurrences of the scale enemy may be controlled to a certain extent by an introduction of the parasitic insect the moment the scale has begun to be abundant, in this manner assisting the early multiplication of the natural enemy. This is practically accomplished now in the case of the black scale on the Cooper ranch and a few other localities in California, and in the case of the fluted scale in California, South Africa, and Portugal. To succeed in such efforts, it is necessary to have an efficient parasite or predaceous insect, and also regular breeding places where these may be secured when wanted. These conditions may be naturally supplied when a whole district, such as California, is under constant observation and the localities where the parasite and scale are occurring together are known. From such points the ladybirds or other enemies may be collected and shipped to the districts needing them. By such constant transportation and recolonization the parasite is kept from nearly complete extermination, and is available when needed.

### THE DIRECT MEANS OF CONTROLLING CITRUS SCALE INSECTS.

Scale insect enemies of citrus trees are controlled in two ways: either by spraying the infested plants with some liquid insecticide or by subjecting them to the fumes of hydrocyanic-acid gas, commonly designated as "gassing." Each of these methods of control has its place.

The gassing method (illustrated in Pls. XXVI and XXVII) is undoubtedly the most effective means known of destroying scale insects. It has been in general use in California for fifteen years, and to a less extent elsewhere on citrus trees, and the methods are now thoroughly perfected and highly satisfactory. Gassing should undoubtedly be employed wherever the expense of the treatment, which is the one objection to it, is not an object as measured by the value of crop protected. For most species of scale insects, one good gassing is worth as much or more than two or three sprayings, and when done at the right season and properly it very frequently will almost, if not quite, exterminate the scale insects from the treated trees, giving them comparative immunity often for two or more years. This is especially true of the black scale and the California red scale. The use of hydrocyanic-acid gas is, therefore, strongly urged wherever the conditions warrant it. Gassing is especially desirable for trees that have a dense habit of growth, such as the orange, which develops

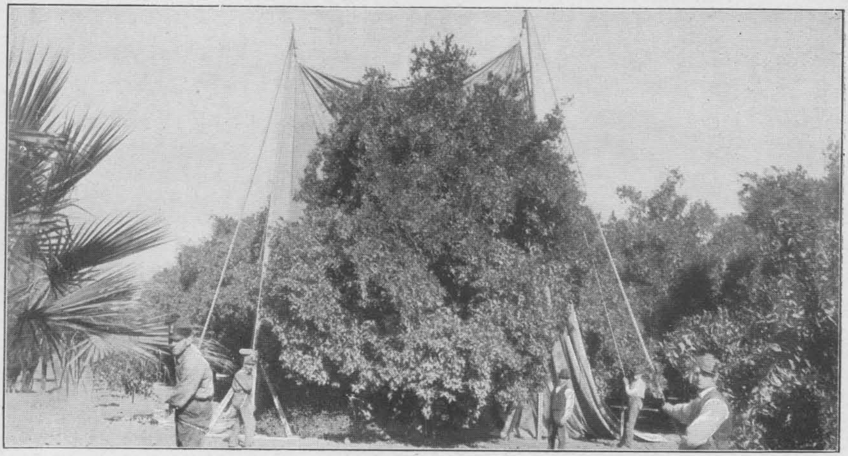

FIG. 1.—METHOD OF HOISTING TENT OVER ORANGE TREE.

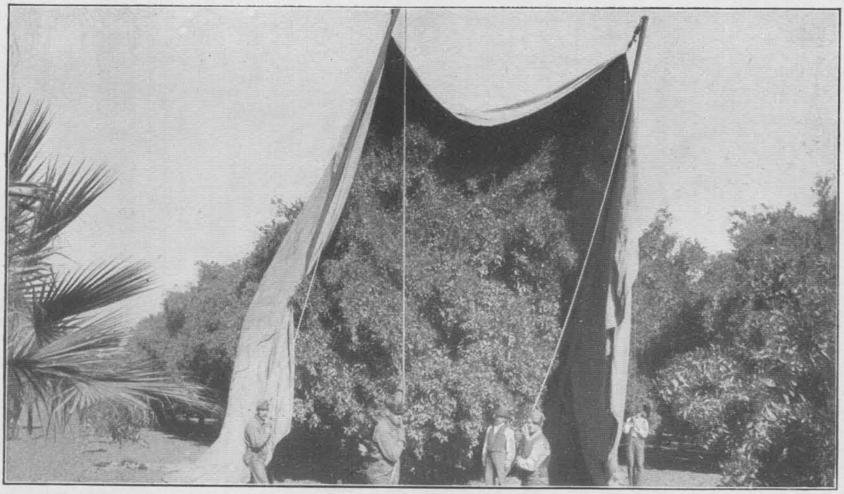

FIG. 2.—TENT CARRIED OVER TREE BY THE FALLING OF PULLEYS.

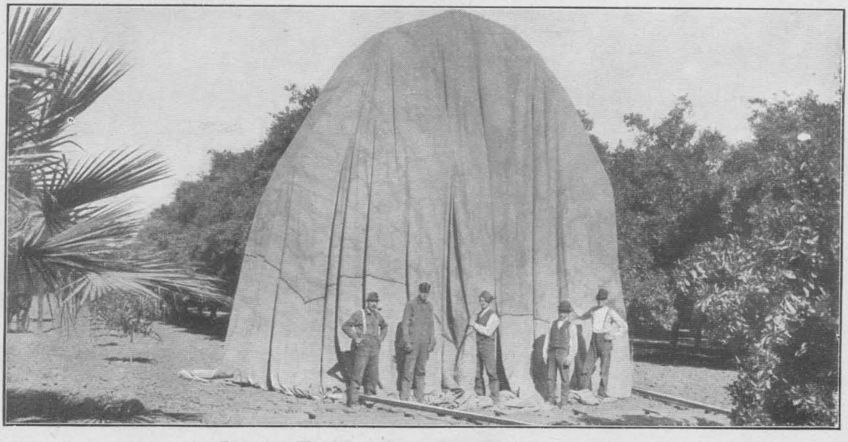

FIG. 3.—TENT IN POSITION FOR FUMIGATION.

FIG. 1.—REMOVING TENT BY HORSEPOWER.

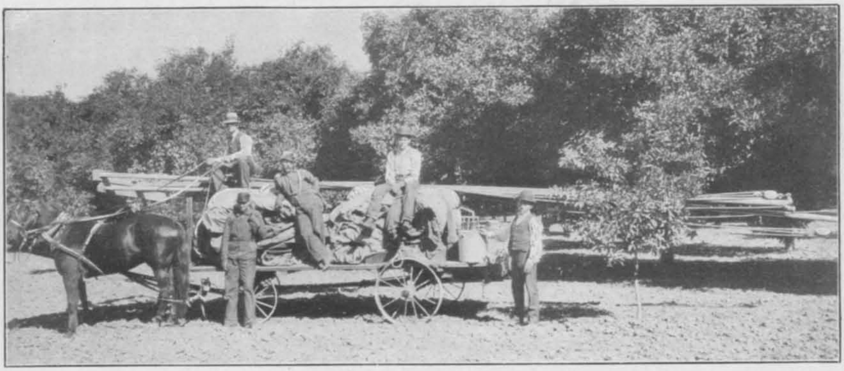

FIG. 2.—TENTS, TACKLE, AND CHEMICALS LOADED FOR TRANSPORTATION.

FIG. 3.—A SAN DIEGO FUMIGATING OUTFIT.

a large, thick head, the spraying of which thoroughly and completely is almost an impossibility, especially after the trees have attained any size. The more straggling growth of the lemon makes gassing less necessary, notably where the open system of pruning is adopted.

It may often happen that gassing is impracticable or that the expense of the treatment, in view of the conditions, is not warranted. This last may be the case where the rancher has not sufficient capital to keep up the heavy outlay necessitated by the gassing of young stock which yields no revenue. Gassing is also difficult and less desirable where, as for the lemon in southern California, the low, open-center pruning is adopted, the trees under this system of pruning often having an expanse of 20 feet, with a height of scarcely more than 6 feet. (See Pl. XXVIII, fig. 1.) This open system of pruning and more straggling form of growth, on the other hand, makes the lemon easier to treat with liquid sprays, and under such conditions spraying will probably prove more practicable and profitable than gassing, particularly in view of the comparatively inconsiderable cost of the former. Nevertheless, where lemon trees are of a form and size to admit of it, and the crop warrants the expense, gassing is always to be recommended for the two scale insects mentioned, and others for which it is equally effective. With the orange, except for young trees, spraying is hardly to be advised, especially in view of the general custom of pruning this tree but little, if at all, and allowing it to form oval dense tops.

The expense of spraying is not heavy, compared with gassing. In most of the citrus districts of California where spraying is practiced to any extent there are individuals who make a business of treating orchards at a charge of a cent a gallon for the liquid applied, or about double when they furnish as well as apply the insecticide. This work is now commonly done with a power apparatus, and usually in a fairly satisfactory manner. (See Pl. XXIX, figs. 2 and 3 and Pl. XXX, figs. 1 and 2.[1]) The difficulty in depending on the public sprayer is that it is very often not available when much needed. For a large ranch, the possession of a power spraying outfit will probably prove economical in the long run, and anyone contemplating securing one is referred to the general article on such machines, by Dr. L. O. Howard, in the Yearbook of this Department for 1896.

For the small rancher, having from 10 to 30 acres of orchard, it is not necessary to go to the expense of a steam or a gasoline spraying apparatus. There are a great many excellent force pumps on the market which may be easily equipped with suitable hose and nozzles, and which will do the work of spraying very satisfactorily. A hand force pump with suitable connections, which may be equipped for work

[1] Figs. 2 and 3, Pl. XXIX, from photographs furnished by G. P. Hall, and figs. 1 and 2, Pl. XXX, by F. G. Havens and F. Kahles.

at a cost of from $25 to $30, will meet all requirements. The spraying outfit of this sort which the writer had put together for use on his ranch in southern California, and which is illustrated on Pl. XXVIII, figs. 2 and 3, proved to be most efficient. Another effective hand outfit employed on the ranch of Mr. J. E. Thoustrup, at La Mesa, Cal., is illustrated on Pl. XXIX, fig. 1. The pump for such an outfit should be capable of easily producing a pressure of 100 pounds, which will supply four cyclone nozzles attached to two lines of hose. With such an apparatus, the writer was able to apply easily 50 gallons an hour, or 500 gallons a day, working with three men, and this covers also the time lost in mixing the insecticide and refilling. The cost of applying the same amount of liquid by a contract sprayer would represent as much as the cost of the labor of the three men, one to pump and one for each line of hose; furthermore, the work being under personal supervision will be undoubtedly better done and with less waste of material, and, of more importance still, at the time when most needed and when the greatest advantage will result.

Trees under seven years old will probably not require more than a gallon of spray—ranging from half a gallon to a gallon. An orchard of 10 acres of trees, planted on the hexagonal system, 24 feet apart, gives 86 trees to the acre, or 860 trees for 10 acres, and would represent a cost of spraying of about $8 for the spray and as much more for the labor. In other words, spraying with the insecticides commonly employed, such as "distillate," kerosene emulsion, and resin wash, may be safely estimated to cost about 2 cents a gallon for the amount of liquid used, or not exceeding 2 cents per individual tree under seven years of age. On the other hand gassing a tree of seven years of age will cost from 12 to 15 cents per tree, or the equivalent of from five to seven sprayings. The advantage, therefore, of spraying, for the small owner, and for trees especially suited by form of growth or pruning to such treatment, is evident.

Successful as gassing is, it is not effective in the same degree against all the scale insect enemies of citrus plants. For example, some of the armored scales require two or three gassings to effect anything like extermination, rendering the treatment almost prohibitive. Gassing is also not effective against the rust mite. It is especially valuable against the black scale and the red scale of California. With such of the armored scales as are oviparous, or deposit beneath the old scales eggs which undergo a certain amount of incubation before hatching, gassing is not always effective. Under such circumstances it will only kill the young and developing insects, but often many of the eggs and, in some instances, even the old females are not destroyed, rendering it necessary to make additional treatments after a sufficient period has elapsed to allow all the eggs to hatch and the young to escape. For all these insects, spraying is, as a rule, more desirable than gassing,

FIG. 1.—BARONIO TRAINING OF THE LEMON, ADAPTING THE TREE FOR SPRAYING RATHER THAN GASSING.

FIG. 2.—HAND-SPRAYING APPARATUS IN LEMON ORCHARD, LAMESA, CAL.

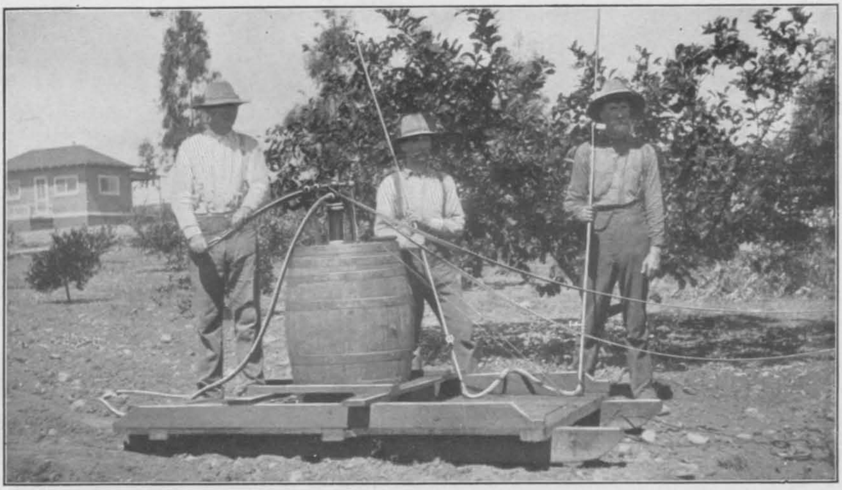

FIG. 3.—CLOSER VIEW OF HAND-SPRAYING APPARATUS OF FIG. 2, SHOWING CONSTRUCTION.

FIG. 1.—THE BEAN-SPRAY PUMP IN OPERATION.

FIG. 2.—GASOLINE-SPRAYING OUTFIT, CHULAVISTA, CAL.

FIG. 3.—SAME OUTFIT AS SHOWN IN FIG. 2, SPRAYING LEMON TREES.

FIG. 1.—STEAM SPRAYER, USED AT RIVERSIDE, CAL.

FIG. 2.—GASOLINE SPRAYER, CROCKER-SPERRY LEMON GROVE, SANTA BARBARA, CAL.

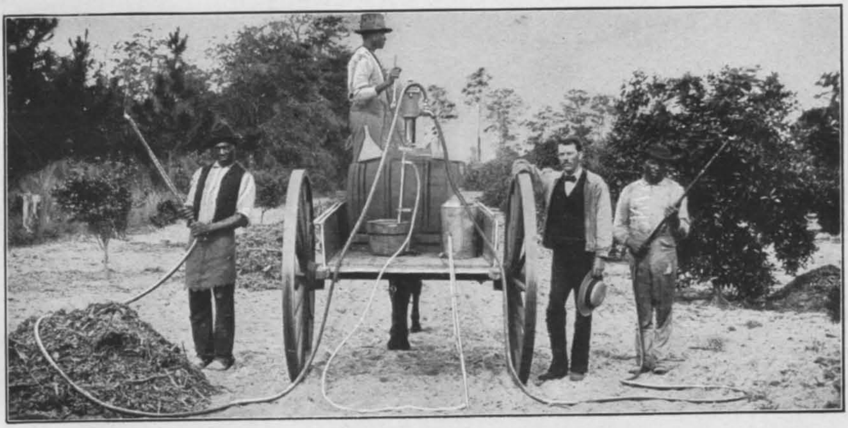

FIG. 3.—OLD-TIME FLORIDA HAND-SPRAYING OUTFIT.

because the expense of treatment is much less and there is more likelihood of its being repeated with sufficient frequency to accomplish the desired result.

The gas treatment for the black scale, however, is often most striking in its results. Applied late in October or early in November after all the young scales have hatched, as noted by the writer, badly infested orchards have been completely cleaned in a single gassing. The black scale is especially adapted to control by gassing on account of its being, in the main, single brooded, practically all of the scales being in a young or partly grown condition at the period designated. Gassing in midsummer for this insect will be ineffective, because a large percentage of the old females at this period cover and protect unhatched eggs.

### Method of Gassing Trees.

The details of the use of hydrocyanic-acid gas as a fumigant for scale insects on growing trees are so well known in the citrus districts, at least in California, that a minute description of the process is unnecessary. Briefly, the treatment consists in inclosing a tree at night with a tent and filling the latter with the poisonous fumes generated by treating refined potassium cyanide (98 per cent strength) with commercial sulphuric acid (66 per cent) and water.

The proportions of the chemicals as now employed in California are considerably in excess of the amounts recommended a few years since, or as recently as 1898. The gas treatment was first chiefly used against the black scale, and at a season of the year when these scales were all in a young stage and easily killed. The effort is now made not only to kill the black scale but also the red scale, and to do more effective work even than formerly with both of these scale insects. The proportion of chemicals ordinarily advised and commonly employed in Los Angeles, Orange, and some other counties in southern California are indicated in the following table, published by the horticultural commissioners of Riverside County, Cal.:

*Proportions of chemicals ordinarily used in gassing.*

| Height of tree. | Diameter of tree. | Water. | Cyanide C. P. (98 per cent). | Sulphuric acid (66 per cent). |
|---|---|---|---|---|
| *Feet.* | *Feet.* | *Ounces.* | *Ounces.* | *Ounces.* |
| 6 | 4 | 2 | 1 | 1 |
| 8 | 6 | 3 | 1½ | 1½ |
| 10 | 8 | 5 | 2½ | 2½ |
| 12 | 14 | 11 | 5 | 5½ |
| 16 | 16 | 17 | 8 | 9 |
| 20 | 16-20 | 22 | 10 | 12 |
| 20-24 | 18-22 | 30 | 14 | 16 |
| 24-30 | 20-28 | 34 | 16 | 18 |
| 30-36 | 25-30 | 52 | 24 | 28 |

The amounts here recommended are thoroughly effective for the black scale at the proper season, and generally effective also for the California red scale and other armored scales. Where the treatment is designed to be absolutely one of extermination, and the expense is not considered, from one-third to one-half more of cyanide and acid is employed, as indicated in the table following, furnished by Mr. Felix G. Havens, of Riverside. The amounts here recommended may be employed also for compact trees with dense foliage.

*Excessive amounts used for extermination.*[1]

| Height of tree. | Diameter through foliage. | Water. | Sulphuric acid. | Cyanide. | Time to leave tent on tree. |
|---|---|---|---|---|---|
| *Feet.* | *Feet.* | *Fluid ounces.* | *Fluid ounces.* | *Ounces.* | *Minutes.* |
| 6 | 3 to 4 | 3 | 1½ | ¾ to 1 | 20 |
| 8 | 5 to 6 | 6 | 2¼ | 2 | 30 |
| 10 | 7 to 10 | 15 | 5 to 6 | 4 to 5 | 35 |
| 12 | 9 to 12 | 20 to 30 | 7 to 9 | 5½ to 7½ | 40 |
| 14 | 12 to 14 | 30 to 35 | 9 to 12 | 8 to 10 | 40 |
| 16 | 12 to 15 | 35 to 40 | 12 to 14 | 10 to 12 | 40 |
| 18 | 14 to 16 | 45 to 55 | 15 to 18 | 12 to 15 | 40 to 50 |
| 20 | 16 to 18 | 60 to 70 | 20 to 22 | 16 to 20 | 45 to 50 |
| 22 | 16 to 18 | 70 to 75 | 22 to 25 | 20 | 50 |
| 24 | 18 to 20 | 75 to 80 | 25 to 30 | 22 to 26 | 50 |
| 27 | 20 to 24 | 85 to 100 | 30 to 36 | 28 to 32 | 60 |
| 30 | 20 to 28 | 100 to 110 | 36 to 44 | 32 to 38 | 60 |

The table on page 257 indicates for the smaller trees twice as much cyanide and acid as was formerly advised, and for the larger trees three times the former amounts. The above table indicates a considerable increase over the first, and three or four times as much of the chemicals as was generally recommended as late as 1898. The greater expense entailed by this larger quantity of chemicals is offset by the more effective results and the consequently longer intervals between treatments. Mr. Havens suggests, in connection with his table, that for small trees ordinary earthenware vessels may be used to generate the gas. For large trees requiring heavy doses tall wooden pails have proved more practicable, two generators being employed for the very largest trees. It is important that the water be put in the vessel first,

[1] A fumigation of the orangery of the Department of Agriculture, December 3, 1900, demonstrated that 0.15 of a gram of cyanide to the cubic foot, or a little more than half an ounce to the hundred cubic feet, is completely exterminative of scale insects, effectually killing the eggs, even of the black, purple, and other scales. The strength mentioned is that ordinarily recommended for violet houses, and the results are scarcely comparable to the proportions recommended in tables on pages 257 and 258, for the reason that in these tables the amount of cyanide is greatly lessened with larger trees, and furthermore, that the orangery probably retained the gas more effectually than would be the case with cloth tents. Nevertheless, it is interesting to know that a comparatively inconsiderable strength of cyanide, when applied under the best conditions, will prove thoroughly effective against the eggs as well as the insects.

and then the acid, and lastly the cyanide. If the water and cyanide are put in the vessel first and the acid poured in afterwards there is danger of an explosion, which will scatter the acid and burn the tents and the operator. In the spring, when the trees are tender with new growth, and in early fall, when the oranges are nearly grown and the skins are liable to be easily marred, and also with young trees, it is advisable to add one-third more water than ordinarily used, or the cyanide in larger lumps. This causes the gas to generate more slowly and with less heat, and if the tents are left over the trees a third longer the effectiveness of the treatment will not be lessened.

The extremely dangerous nature of the gas must be constantly borne in mind and the greatest caution should be taken to avoid inhaling it. The treatment is made at night, and the person handling the chemicals should always have an attendant with a lantern to hold up the tent and enable the cyanide to be quickly dropped into the generator and to facilitate the prompt exit of the operator.

As with spraying, the gassing is often done (and this is very desirable also) by individuals or companies who make a regular business of it, charging a fixed rate per tree, depending on size—from 10 cents to a dollar or more. Much of this work is also done under the direct supervision of the county horticultural commissioners, which gives a greater assurance of efficiency.

Practically the only tent now used is the so-called "sheet tent," which is drawn up over the tree by means of pulleys, as indicated on Pls. XXVI and XXVII. For very large trees, averaging 30 feet in height, it is sometimes necessary to employ two sheets to effect a complete covering.

Some of the tents employed are of great size, the one illustrated in the plates, from photographs secured for us by Mr. Havens, having a diameter of 76 feet. As described by Mr. Havens, it is constructed of a central piece 50 feet square, of 10-ounce army duck. Four triangular sidepieces, or flaps, of 8-ounce duck, 10 feet wide in the middle, are strongly sewed to each side of the central sheet, forming an octagonal sheet 70 feet in diameter. About the whole sheet is then sewed a strip of 6-ounce duck 1 yard wide. The tent is handled by means of ropes and pulleys. A 1½-inch manila rope is sewed about the border of the central piece in an octagonal pattern. Rings are attached to this rope at each of the eight corners thus formed, and also on either side of the tent. To these rings the pulley ropes are fastened and the tent is elevated over the tree and handled as indicated in the plates.

The treatment is made altogether at night, although it would be possible to treat trees also on a very dark or cloudy day. In California, however, at the time the gas treatment is made, such days are infrequent. About 50 trees of the largest size, 30 feet high or thereabouts, can be treated in a night with an equipment of twelve or fifteen tents. With smaller trees, the number which can be treated in a single night is very considerable, it being possible to gas from 300 to 500 trees, averaging 10 feet in height, in eleven or twelve hours, employing thirty-five to forty ring tents.

### Sprays for Citrus Trees.

The oily washes are by far the best for use on citrus trees against scale insects. The attempt has been made in various places to substitute lye washes for the old standard kerosene washes, but the effect has, as a rule, been disastrous. Lye applied to a tree strong enough to kill scale insects, as demonstrated by Hubbard fifteen years ago, is very destructive to the tender growth of the tree, and the damage from the wash is often greater than that occasioned by the insects themselves. The kerosene and resin washes formerly used in California have now given place, to a considerable extent, to a modification of kerosene emulsion known as "distillate." As now employed, the washes in the order of their popularity are: (1) Distillate; (2) resin wash; (3) kerosene emulsion. The probability is that distillate will ultimately supplant the other two on account of its equal, if not greater, efficiency and smaller cost.

Distillate.—This wash was originated by Mr. F. Kahles, the very efficient superintendent of Las Fuentes Rancho, belonging to Messrs. Crocker & Sperry, Santa Barbara, Cal. It has been recommended by Professor Lelong, of the State board of horticulture, and has found very general use in the Santa Barbara region, and also in the lemon districts adjacent to San Diego, as well as in other citrus districts in California. It is substantially an emulsion of crude kerosene, made in the same way as kerosene emulsion, except that a greater amount of soap and only half as much oil are used. Its cheapness arises from the fact that it requires only half the quantity of oil, and in spite of this lessening of oil it seems to be, if anything, stronger than kerosene emulsion, judging from the writer's experiences with it in southern California.

It is termed distillate spray, because the oil used is a crude distillate of the heavy California petroleum. The product used for spraying purposes should have a gravity of about 28° Baumé, and is the crude oil minus the lighter oils, or what distills over at a temperature between 250° and 350° C. It is similar to the lubricating oils in characteristics.

The emulsion or, as it is generally known, "cream" is prepared as follows: Five gallons, "28° gravity," untreated distillate; 5 gallons water, boiling; 1½ pound whale-oil soap. The soap is dissolved in the hot water, the distillate added, and the whole thoroughly emulsified by means of a power pump until a rather heavy, yellowish, creamy emulsion is produced. This emulsion is very similar to the product obtained with refined kerosene, following the old kerosene emulsion formula, except that it is slightly darker in color. For use on citrus trees it is diluted with from 12 to 15 parts of water. The former dilution is the greatest strength advisable, and is for the lemon. It should be diluted with 15 parts of water for applications to the orange, the lemon standing readily the stronger mixture. The "distillate cream" is prepared and sold by oil companies and private individuals at from 10 to 12 cents a gallon, making the dilute mixture, as applied to the trees, cost in the neighborhood of a cent a gallon. The writer found kerosene emulsion, made by the same companies, to cost from 12 to 15 cents a gallon, the item of cost, therefore, being in favor of the distillate. Either of these emulsions can be made at home at a considerable saving over these prices if one is provided with the necessary equipment. In using these oil emulsions, it is advisable to first break the water by the addition of a little lye, a fourth of a pound of lye being ample for 50 gallons of water.

KEROSENE EMULSION.—This wash, made according to the old formula (kerosene, 2 gallons; whale-oil soap, one-half pound; water, 1 gallon), is prepared in the same way as the distillate and used at the same strength. It does no harm to use double the quantity of soap indicated, securing in this manner a rather more stable emulsion and one not so easily affected by hard water. It is always advisable, however, to break the water with lye, as indicated above. This emulsion, while perhaps somewhat less efficient than the distillate emulsion, differs from the latter in effectiveness very slightly at the most, and is always available where the latter may not be in reach. It may be prepared on a small scale with an ordinary hand pump, but is best prepared in large quantities with a gasoline or steam-power pump to mix and emulsify it after the soap has been dissolved in the water by boiling.

THE RESIN WASH.—This wash is especially valuable against the California red scale. It may be also used against any other scale insect, including the black scale and the various armored scales affecting citrus trees. The wash is made as follows: Resin, 20 pounds; caustic soda (78 per cent), 5 pounds; fish oil, 2½ pints; water to make 100 gallons. Ordinary commercial resin is used and the caustic soda is that put up for soap establishments in 200-pound drums. Smaller quantities may be obtained at soap factories, or the granulated caustic soda may be used, 3½ pounds of the latter being the equivalent of 5 pounds of the former. Place these substances with the oil in a kettle with water to cover them to a depth of 3 or 4 inches. Boil about two hours, making occasional additions of water, or until the compound resembles very strong, black coffee. Dilute to three times the final bulk with hot water, or with cold water added slowly over the fire, making a stock mixture to be diluted to the full amount as used. When sprayed, the mixture should be perfectly fluid, without sediment, and should any appear the stock mixture should be reheated; in fact, the wash is preferably applied hot. This wash is much more difficult to prepare than the kerosene emulsions referred to above, and, while it is an excellent wash, it probably will be ultimately largely supplanted by the emulsions of kerosene.

## A Consideration of the Important Insects Affecting Citrus Fruits.

### CITRUS SCALE INSECTS: CLASSIFICATION AND CHARACTERISTICS.

A marked diversity in the life history and habits of the scale insects divides them into distinct groups or subfamilies. For the purpose of this paper, however, a very simple classification may be adopted, namely: (1) The armored scales, or those forming a protective covering scale and losing their limbs and the power of changing their situation as soon as they settle down to feed as newly hatched larvæ; (2) those species which secrete no covering shell or scale and retain their limbs and the power of moving about during most of their lives.

The species belonging to both groups are commonly called scale insects, although the term might seem properly to apply only to the first group; nevertheless, the old insects in the second group, when they become hardened, and, in fact, the younger stages also, have very much a resemblance to scales; hence, the name may properly apply to them as well.

These insects all belong to the family Coccidæ of the order Hemiptera, or true bugs, being allied to plant lice and other suctorial insects of this order. In the larval stage, the scale insects, except in point of size, closely resemble the larvæ of the higher forms of Hemiptera, and are active and can run about on plants or may be carried from one plant to another by the agency of winds or by birds or by other insects, to which they may attach themselves.

In the case of the armored scales, as soon as the young have undergone their first molt they appear as a mere sack, provided with a long sucking beak, but without legs or eyes, and are very much degraded structurally from the larval condition. The unarmored scales, while retaining their limbs throughout life, are not apt to move very much after they have once settled and begun to feed, except in the case of one or two species. The power of locomotion, however, is retained, and in the case of the fluted scale and mealy bug is often actively brought into play; the Lecaniums and wax scales are apt to migrate late in their lives from the leaves to the twigs. The female insects of both groups remain on the plants and never advance to a winged stage. The males of both groups, however, while paralleling the development of the females in the early stages, in the later stages transform to pupæ or chrysalids, and eventually emerge as minute, two-winged gnats. The life of the winged male is very short, and its sole function is to fertilize the eggs of the female. It is a very delicate creature, having no mouth parts, but in place of them a second pair of prominent eyes.

Group 1, comprising the armored scales, will first be considered.

### Group 1. The Armored Scales.

The majority of the important scale-insect enemies of the orange belong to the group of scales known as armored scales, from the circumstance already described of the insects' beginning to secrete, as soon as they thrust their beaks into the tissues of the plant, a waxy scale covering, which protects the growing insect and forms a definite scale-like shield entirely independent of the insect itself. This group includes the long scale, purple scale, the red scale of California, and the red scale of Florida (an entirely distinct insect), the oleander scale, the chaff scale, and other less important species.

In general habits these armored scales are very similar. The eggs, which are developed in enormous numbers, may be extruded under the covering scale of the mother insect and experience a longer or shorter period of incubation before hatching, or the young may be partly or fully developed within the body of the mother and emerge as active insects, or more properly shake off the egg envelope at the moment of birth, so that certain species appear to yield living young. The young of these different species of armored-scale insects very closely resemble each other, and could not be distinguished without careful microscopical study. While very minute, the young are yet visible to the naked eye, and during the breeding season may be seen, by sharp inspection, running about on the leaves, twigs, and fruit. In color they are usually light lemon-yellow. They have six well-developed legs, also antennæ and eyes, and are highly organized in comparison with the degraded condition soon to be assumed. After finding a suitable situation, often within a few minutes from the time of their emergence from beneath the old scale, though sometimes not for an hour or two, they settle down, thrust their long, slender, hair-like beaks into the plant, and immediately begin growth, the first evidence of which is the secretion of waxy filaments from the upper surface of the body, which mat down and form the beginning of the scale covering. (See fig. 12.) This waxy secretion continues during the life of the insect, the covering scale being enlarged as the insect increases in size. The females undergo two molts, and the skins thrown off in these molts attach to the scale and form a definite part of it, being cemented to it closely with the wax. The female insect, after the second molt, soon reaches full size, and when fertilized by the male begins to develop her numerous progeny of eggs or young.

The preliminary stages of the male scale insect exactly correspond with those of the female. After the first molt, however, the male assumes a slightly different appearance, being more elongate than the female at this stage. With the second molt the male diverges entirely from the female; the old skin is thrust out from beneath the covering scale and does not become a part of it, as with the female, so that in the case of the male insect the first shed skin only is associated with the scale, which never becomes more than one-half the size of that of the female. With this second molt, the male insect transforms to a preliminary pupal stage, in which the antennæ, legs, and wings are partially developed. A third molt occurs with the male insect, resulting in the final pupal stage, which exhibits more fully formed legs and wings than the last stage and also the so-called terminal stile. A fourth and last molt of the male produces the perfect insect, which escapes from beneath the covering scale and can fly about. (See fig. 11.)

The periods between the moltings vary with different species and with weather conditions. Most of the species, however, reach full growth in from four to six weeks in summer; development is slower in winter.

The female insect, having once thrust her beak into the tissues of the plant as a larva and begun the secretion of a covering scale, never moves from her position; and, in fact, if she be removed by force is never again able to penetrate the bark with her sucking beak, and soon perishes. The opportunity for the local spread, therefore, of these insects is limited absolutely to the larval stage, differing in this respect from the Lecaniums and mealy bugs, which have the power to move and change their position until nearly the end of their growing period.

The number of eggs deposited by a single female armored-scale insect varies somewhat with the species, but may be from 100 to 500 individuals, and is more apt to approach or exceed the latter figures. The number of young produced varies with the season, a less number being generated in unfavorable than in favorable seasons of the year. The progeny from a single parent insect in a year, on the supposition that they should all survive, would represent almost inconceivable numbers, running into the billions. It is not to be wondered at, therefore, that plants become thoroughly infested with these insects in a very short period of time, especially in climates where the breeding is but little checked by the winter season.

The waxy covering of these insects makes it necessary to use rather strong washes to penetrate the scale and destroy the protected insect beneath. The difficulty increases when the old scale protects a mass of eggs, as is usually the case with the species of Mytilaspis, represented by the long and purple scales; and it is not always possible with the best washes to kill all the eggs of these species, hence the necessity of spraying repeatedly to overtake and destroy the young as they emerge. The older the scale the more difficult it is to destroy it with insecticides, and, conversely, it is easier to destroy young scales or immature ones. Remedial operations, therefore, should be instituted as far as possible when the greatest percentage of the scales are in a young or partly mature condition. A consideration of the important citrus species belonging to this group follows.

### THE LONG SCALE.

(*Mytilaspis gloveri* Packard.)

The long scale (fig. 9) is supposed to have originated in China, from whence it was carried to the citrus regions of southern Europe. It made its appearance in Florida in 1838, or perhaps earlier, and very soon became a very serious pest throughout the groves in that State and elsewhere in the Gulf region. At its first appearance it was vastly more destructive than it became later on, the parasitic and natural enemies having in later years kept it decidedly in check. At the present day it is everywhere distributed throughout Florida and Louisiana in the orange and lemon groves, and also on wild orange. Strangely enough, it was a long while getting into California. About 1889 or 1890, however, in company with the purple scale and rust mite, it was carried into California on a lot of stock from Florida, but it has not developed as a very serious pest in the Pacific coast region.

FIG. 9.—Long scale (*Mytilaspis gloveri*): Group figure, showing cluster of male and female scales on fruit of orange—enlarged 7 diameters (original).

This insect, in common with most of the other species discussed, has a world-wide distribution, being represented in practically every important citrus region, including Mexico, South America, Japan, China, Australia, the East Indies, Ceylon, Hawaii, etc. As its name indicates, it is characterized by its very elongate form. In other respects it closely resembles *Mytilaspis citricola*, and also the common oyster-shell scale of the apple and other deciduous fruits. In color it is a rather rich reddish, often obscured by extraneous matter taken from the surface of the leaves or bark. It apparently requires a great deal of moisture to thrive well, and hence is especially apt to be abundant on oranges or other plants grown in conservatories, and this also accounts, doubtless, for its greater multiplication and injury in Florida than on the Pacific coast. It has from three to four indistinctly defined generations in a year. Breeding continues practically throughout the season, the periods of growth being somewhat slower in the cooler rainy season of winter than in the summer. According

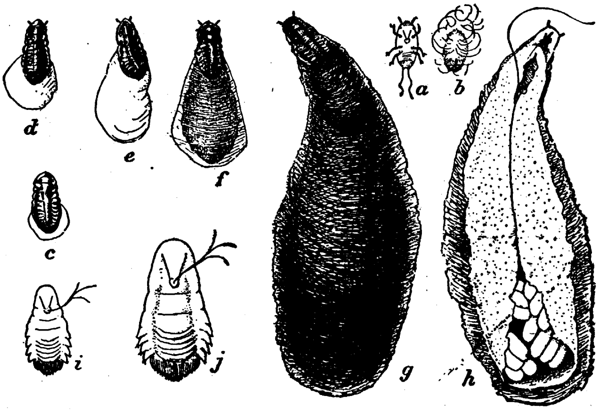


FIG. 10.—Purple scale (*Mytilaspis citricola*), showing different stages of female: *a*, newly-hatched larva; *b*, same with first waxy secretion; *c* to *f*, different stages of growth; *g*, mature scale; *h*, same inverted, showing eggs; *i* and *j*, half-grown and full-grown female insects removed from scale—all much enlarged (original).

to Hubbard, there are three periods in Florida when the young are especially abundant, marking in a rough way the appearance of the main broods, namely, in March and April, in June and July, and in September and October; the fourth, irregular brood, occurring in January or February.

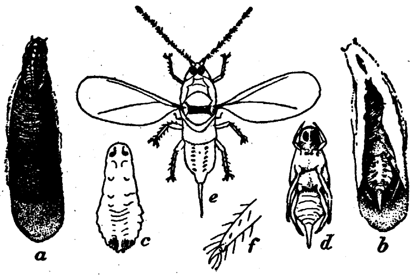


FIG. 11.—Purple scale (*Mytilaspis citricola*), showing different stages of male: *a*, fully developed male scale; *b*, same inverted, showing male pupa within; *c*, propupa; *d*, final pupal stage; *e*, mature winged insect; *f*, foot of same much enlarged—all greatly enlarged (original).

This scale insect is kept in check to a considerable extent, as already indicated, by various parasitic flies, and also by the attacks of different ladybirds. The treatment for this scale is in the use of the oily washes and fumigating with hydrocyanic-acid gas. The oviparous habit of the species renders all of these treatments somewhat ineffective unless thoroughly and strongly applied, the destruction of all the eggs necessitating, as a rule, more than one application to effect a riddance. It is much more easily controlled, however, than the purple scale.

## THE PURPLE SCALE.

(*Mytilaspis citricola* Packard.)

The original home of the purple scale is unknown, but it now occurs practically wherever the orange or lemon is grown. It was probably introduced into this country at an early date, but when and where has never been determined. It is frequently associated with the long scale, and is one of the most troublesome scale insects affecting the orange and lemon, because, like the long scale, the female insect deposits her eggs beneath the covering scale, which with this species is so tough and dense that it is very difficult to get an application on the trees strong enough to kill all of the eggs with one treatment. For many years the purple scale was limited in this country to Florida and the Gulf region, but some years since, in company with the long scale and the orange rust mite, it was carried on Florida stock into southern California, where its action has been very mischievous, but where, fortunately, it has not yet become widely distributed. This scale insect (figs. 10, 11, and 12), in common with the long scale, infests the leaves, bark, and fruit. In general color it is a brownish purple, and in shape exactly duplicates the oyster-shell scale of the apple, being shorter and considerably broader than the long scale and somewhat curved, or horn shaped. The life history and habits exactly duplicate those of the long scale. The purple scale is not limited to citrus fruits, but occurs also on many other plants.

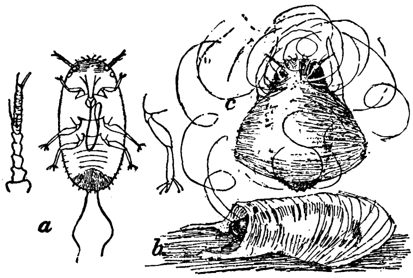


FIG. 12.—Purple scale (*Mytilaspis citricola*), illustrating the formation of the scale covering: *a*, newly hatched young, with enlarged antennæ at left and leg at right; *b*, side view of forming scale; *c*, same from above—all greatly enlarged (original).

Neither the gas treatment nor any of the washes is a certain remedy for this scale, except in the immature stages. Occasionally a very strong treatment with gas or wash will kill the eggs, as has been demonstrated in the orangery of the Department, but this can not be relied upon, and it is usually necessary to repeat the application once or twice at intervals of two or three weeks to effect anything like extermination.

### THE RED SCALE OF FLORIDA.

(*Aspidiotus ficus* Ashmead.)

This is another scale insect of world-wide distribution. As an orange scale it is not a very serious pest on trees grown out of doors. On trees, however, grown in conservatories or under glass it is very apt to thickly infest the leaves and fruit. It has a very wide range of food plants other than the orange and lemon, and is one of the commonest of scale insects. This and the following species differ from the Mytilaspis scales in being more nearly circular in general outline, with the cast or molted skins in the center of the scale instead of at the small end. (See fig. 13.)

The color of this scale is a rich reddish brown, almost black. The central portion, however, represented chiefly by the cast skins, is much lighter, giving the appearance of a dark ring with a light center. The number of generations of this insect can not be accurately given, breeding going on throughout the year, but undoubtedly in greenhouses and tropical regions six or seven generations are not unusual, and in subtropical regions five generations may be safely counted. This scale infests indiscriminately leaves, fruit, and limbs. It seems never to have attracted any attention as an enemy in the orange and lemon groves of California, the dry climate evidently not suiting it. The moist climate of Florida and the Gulf region seems more favorable to it.

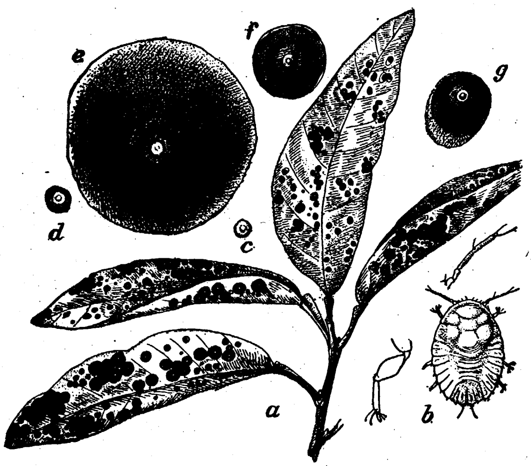

FIG. 13.—Florida red scale (*Aspidiotus ficus*): *a*, leaves covered with the male and female scales—natural size; *b*, newly hatched insect with enlargements of antennæ and leg; *c*, *d*, *e*, *f*, different stages in the development of the female scale, drawn to the same scale; *g*, adult male scale—similarly enlarged (original).

### THE RED SCALE OF CALIFORNIA.

(*Aspidiotus aurantii* Maskell.)

This species (fig. 14) is entirely distinct from the red scale of Florida. Its name comes not from the covering scale, as with the Florida species, but from the fact that the body of the mature female turns a reddish brown and shows through the thin transparent waxy scale. This insect, although for years very common and destructive in the groves of southern California, and enjoying also a cosmopolitan distribution, has, curiously enough, never appeared in a destructive way elsewhere in this country. The origin of this scale is a matter of some uncertainty. It was early a very common pest in the Levant and in China and Australia. It very likely has been a scale pest on trees in Oriental countries for centuries. It does not limit its work to citrus plants, but may occur on almost any plant growing in tropical or subtropical regions. It is the most destructive and injurious of all the scale insects affecting the orange in California, being especially troublesome in the districts about Los Angeles. It attacks the trunk, branches, leaves, and fruit, and, so far, no effective parasites or predaceous insects have been found to combat it. It is controlled by the oily washes and also by the gas treatment. The young are born free, or, in other words, the insect is semioviparous, as already explained, and therefore any wash which will kill the old scale will destroy the young also.

This insect has, in California, a rather well-marked variety, which is known as the yellow scale (*Aspidiotus citrinus* Coq.). This variety does not differ in any structural feature from the red scale, but the mature insect does not turn a reddish brown; it remains yellowish in color, and showing through the scale gives it the color noted in its common name. This variety, curiously enough, is attacked by quite a number of parasitic flies, which keep it more or less in check, so that it is not, as a rule, so abundant as the red variety.

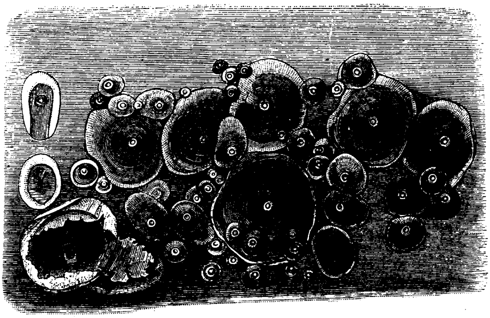

FIG. 14.—California red scale (*Aspidiotus aurantii*), illustrating a group of the female and male scales as they occur on an orange leaf—enlarged about 7 diameters (original).

### THE OLEANDER SCALE.

(*Aspidiotus hederæ* Val.)

This species is not distinctively an orange pest. It occurs on a great variety of plants, and has a world-wide distribution, having been redescribed as a new species twenty-five or thirty times on different food plants. It occasionally occurs on the lemon and orange, especially in California, not apparently being so apt to attack this plant in Florida. It is a very delicate scale, with a very thin waxy covering, and yields readily to treatment. It is very apt to occur on the oleander, and is commonly known as the oleander scale. As its common name indicates, this scale, which, as a rule, thickly covers the portion of the plant attacked, gives a general appearance of a white film. (See fig. 15.) This is due largely to the enormous number of white male scales, which very greatly exceed the female scales in abundance (much more so than indicated in the illustration), and are thickly placed. The female scales are light buff in color with a faint purple tinge, rather than white, and are two or three times the size of the male scales, and rather larger also than the scales of the species already described. The fruit of the lemon and orange is often invaded by the female scales, especially, of this insect, as exhibited by examples recently sent to this office from California.

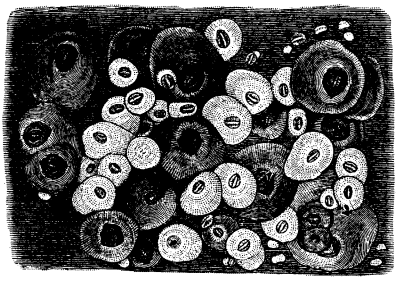

FIG. 15.—Oleander scale (*Aspidiotus hederæ*), illustrating a group of the female and male scales as they occur on a leaf—enlarged about 7 diameters (original).

### THE CHAFF SCALE.

(*Parlatoria pergandei* Comstock.)

This is a scale insect which, in general appearance, lies half way between the Aspidiotus scales and the Mytilaspis scales. In other words, the molted skins are at one end of the scale, as in the case of Mytilaspis, and the scale is oval or nearly circular, as in the case of Aspidiotus. It is very apt to be clustered thickly, often overlapping on leaves or twigs and fruit, giving the surface a rough appearance, as though covered with a loose scale or chaff, hence its common name. (See fig. 16.) In color the female scale is light straw-yellow, the female insect showing through, usually with a greenish tinge. The number of generations and life history correspond very closely with the species already described. As a rule, the chaff scale by preference remains on the trunk and branches, covering these portions of the plant densely before going on the leaves and fruit. This fact renders it somewhat less noticeable than the other species, and its presence may, for a time, be overlooked.

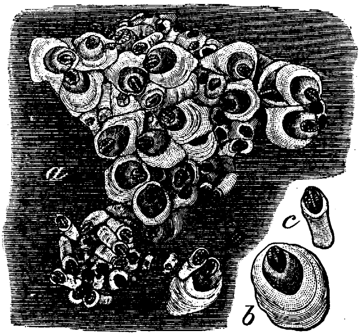

FIG. 16.—Chaff scale (*Parlatoria pergandei*), illustrating a group of the female and male scales as they occur on a leaf—enlarged about 7 diameters (original)

The chaff scale has been destructive, so far, only in Florida and the Gulf region, having apparently been introduced from the Bermuda Islands or some of the West Indies. It was at one time considered as a native insect, but there is no ground for this belief, and it is undoubtedly an introduced species. It is closely allied to certain scale insects occurring in the Old World, and probably came to this country from Europe or Asia. It is kept somewhat in check by parasitic attacks, and also by predaceous insects. It yields to the same treatments which are advised for the other armored scales.

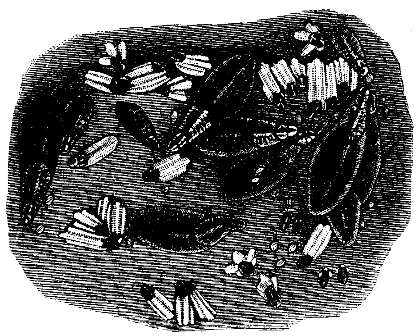
FIG. 17.—Orange Chionaspis (*Chionaspis citri*), illustrating a group of the female and male scales as they occur on a leaf—enlarged about 7 diameters (original).

### THE ORANGE CHIONASPIS.

(*Chionaspis citri* Comstock.)

This species occurs in the orange groves of the Eastern United States, and is also especially troublesome in Louisiana, as first shown by the observations of Dr. Howard, and, later, of Professor Morgan. The latter reports it as being very prevalent from New Orleans to the Gulf, and that its presence on the trees causes a bursting of the bark and very ugly wounds. In very many cases the rotting of the trunks of the older trees follows, and is believed to be due to, the attacks of this insect. The orange Chionaspis is found also in several of the West Indian islands, Mexico, and in most foreign countries where citrus fruits are grown. Fig. 17 illustrates the characteristic appearance of the male and female scales. The former are striking objects on account of their white color, and the latter are readily distinguished from the other armored scales of similar general shape by the distinctly roofed or ridged appearance of the waxy portion. The orange Chionaspis is readily controlled by the same treatments advised for the other armored scales.

### Group 2. The Naked or Unarmored Scales.

The grouping of several species of citrus-scale insects under this head is for convenience only, and does not necessarily represent a close relationship other than in general habits. The species to be considered include three Lecaniums, the mealy bug of the orange and lemon, two wax scales, and the fluted scale. Strictly speaking, the Lecaniums are the only ones which are unarmored, or secrete no covering. The mealy bug secretes a waxy or mealy powder, which covers its body, and a similar secretion in less amount is made by the fluted scale. Both of these species secrete very abundant quantities of wax for the protection of their eggs. The wax scales cover themselves with copious waxy secretion, which, however, attaches firmly to the body, and can not be considered as a separate covering in the sense of the scale of the armored species. The development of the different species in this group is very similar, in that they all retain the power of changing their position, or locomotion, until nearly the end of their lives, and do not exhibit the loss of limbs and the marked retrograde development already described in the case of the armored scales. They all excrete liberally the honeydew, which is followed by the smut fungus. In this group are included some of the worst scale pests of the orange and lemon, notably the black scale, the fluted scale, and the mealy bug. Not being so firmly attached nor so protected by a covering shell or scale, they are as a rule more easily destroyed by fumigation or insecticide sprays, or fall a more ready prey to attacks of predaceous or parasitic insects. All of the species are egg laying. The Lecaniums and wax scales deposit their eggs in cavities under their bodies formed by the contraction of the female insects, so that ultimately the mothers form merely shells over vast numbers of eggs and hatching young. The mealy bugs and fluted scale excrete a quantity of cottony fibers which are stocked with eggs. After a certain amount of incubation the young hatch and escape from beneath the old parent scales or burrow out of their cottony nests. In transformations and general life history, except in the points noted, these scale insects closely duplicate the habits of the armored scales. A consideration of the important citrus species belonging to this group follows.

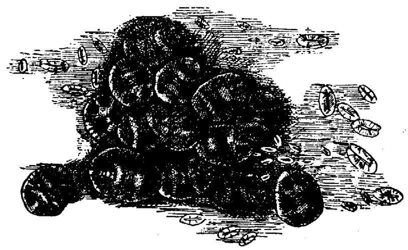

FIG. 18.—Black scale (*Lecanium oleæ*): Group of scales, showing natural position and appearance—enlarged 4 diameters (original).

### THE BLACK SCALE.

(*Lecanium oleæ* Bernard.)

As its scientific name indicates, this scale insect (figs. 18, 19, 20) is properly an olive scale; but it also attacks citrus fruits, and is perhaps even more destructive to the latter than to the olive. It is an insect of world-wide distribution, having been an important enemy of the olive and citrus fruits in the Old World as far back as we have any records. It also affects a great variety of other fruits and plants, very few subtropical plants being free from its attacks. It occurs more or less in greenhouses, and has undoubtedly been transported to various parts of the world upon greenhouse plants as well as upon the various subtropical species. In the United States, curiously enough, it is especially destructive only on the Pacific coast, and while it occurs generally in Florida, it has never there assumed any great importance as an enemy of the orange or lemon. The damage occasioned by this species is not only the serious sapping of the vitality of the plants by the extraction of their juices by the young and growing insects, but also by the abundant secretion of honeydew, which results in a badly attacked plant becoming thoroughly coated and blackened with the characteristic sooty fungus which always accompanies this

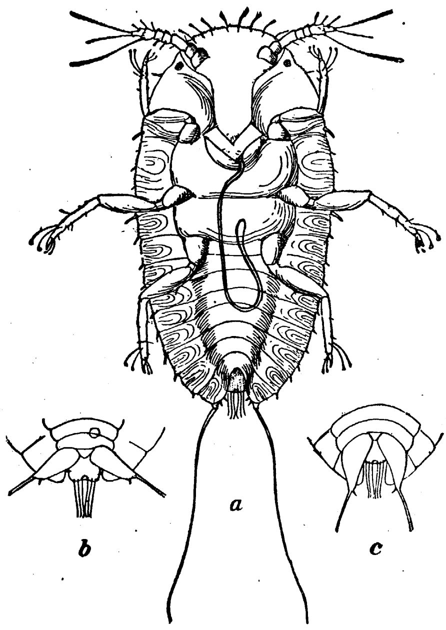


FIG. 19.—Black scale (*Lecanium oleæ*): *a*, greatly enlarged drawing of newly hatched larva, viewed from beneath, with enlargements of anal extremity viewed from above; *b*, showing anal segment extruded; *c*, same retracted (original).

scale insect, rendering the fruit unsalable or greatly depreciating its value.

As its common name indicates, the adult insect is dark brown, nearly black, in color, and even the young insect begins to turn brown almost as soon as it has planted itself and begun to feed. The characteristic features of this scale are the one longitudinal and the two transverse ridges, which become the prominent exterior structural characters in the later stages of the insect. Very often the portion of the longitudinal ridge between the two transverse ridges is more prominent than elsewhere, giving a resemblance in these ridges to a capital letter H. The general surface of the body of this scale insect is shagreened or roughened, which will distinguish it readily, under a hand lens, from the allied species, even before the ridges have become prominent. Very fortunately for the citrus grower the development of this insect is slow, and it has but one brood annually. The young,

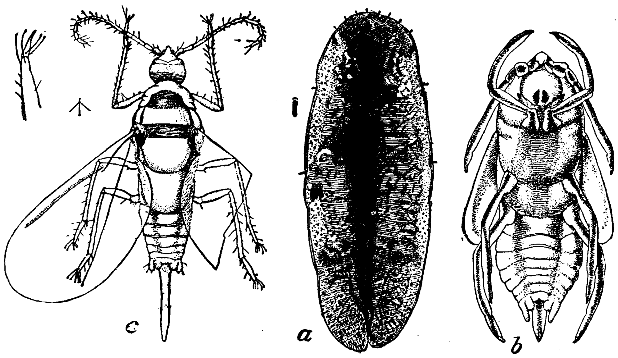


FIG. 20.—Black scale (*Lecanium oleæ*), male series: *a*, fully developed male scale; *b*, pupa; *c*, winged adult—natural size indicated by hair lines (original).

however, appear over a very wide interval of time, and this gives the appearance of more than one brood.

On reaching full growth, early in the summer, the female insect deposits her eggs beneath her already much-hardened parchment-like skin, the lower surface of the body gradually contracting until there is nothing left but the shell, covering a mass of hundreds of eggs. The eggs from a single female will hatch in a comparatively short time, but as the females come to maturity at different dates, the young from this species are constantly appearing and spreading over the infested plants between June and the end of October. The growth, however, is very slow, and even those earliest hatched do not reach maturity until late in autumn, the latest maturing in June and July of the following year.

While retaining the power of movement practically throughout its development, this scale insect is very little apt to change its position after it is once settled, or, at least, after it is half grown. There is a general migration from leaf to twig, but the scale often develops on the leaf if the latter remains vigorous and supplies it sufficient nourishment.

In view of the extraordinary abundance of the black scale it is surprising that until very recently the male insect had not been discovered, in spite of the most careful search for it. Thanks to the enthusiastic study of Dr. B. W. Griffith, a microscopist of Los Angeles, Cal., a good deal has been recently learned concerning the male of this species. His observations were published in the Los Angeles Times of July 2, 1893, and later, with illustrations, by Mr. Alexander Craw in a bulletin of the California State Board of Horticulture. He informs the writer in a recent letter that he has found the male scales on oleander, orange, lemon, pepper, and ivy leaves between the months of November and April, but has never been able to find it outside of Los Angeles County, although he has carefully looked for it on several occasions elsewhere. Some slide mounts and a number of photomicrographs furnished by Dr. Griffith have been used as a basis for the illustration of the different stages of this sex (fig. 20).

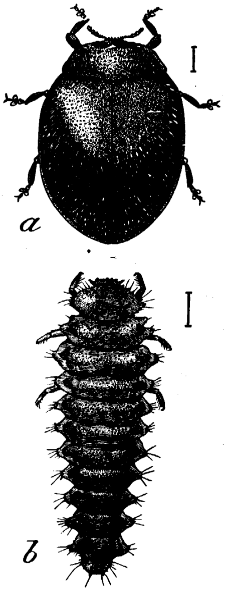

FIG. 21.—Imported ladybird enemy of black scale (*Rhizobius ventralis*): *a*, mature beetle; *b*, larva—both greatly enlarged (author's illustration).

The black scale is kept in check by natural enemies to a very considerable extent. These include both the parasitic flies and various species of ladybirds.

The ladybird enemy of special importance is the *Rhizobius ventralis*, imported by Mr. Koebele. This ladybird (fig. 21) has been colonized in various parts of the State, and in districts where the climatic conditions proved favorable its work has been most satisfactory, notably on the ranch of Hon. Ellwood Cooper, at Santa Barbara. Hundreds of thousands of these beetles have been distributed in southern California and have accomplished in some localities a very great deal of good in keeping the black scale in check. Away from the moist coast regions, however, it is less effective, and experience has shown that this ladybird can not be completely relied upon to control the black scale.

Another parasite of the black scale, which promises to be a most effective means of controlling this pest, was introduced into California during the summer of 1900. It is the very odd-shaped little chalcidid fly (fig. 22) known as *Scutellista cyanea* Motsch., and was first described from specimens bred from *Lecanium coffeæ* in Ceylon. It was later found by Dr. Berlese attacking a wax scale, *Ceroplastes rusci*, in Italy. Subsequent to its discovery in Italy, various efforts were made by Dr. Howard, with the assistance of Dr. Berlese and the latter's colleague, Dr. Leonardi, to introduce it into Florida and the Gulf districts, particularly as a means of controlling the wax scales. The most promising of these importations was the one of 1898, which was colonized at Baton Rouge, La., through the courtesy of Prof. H. A. Morgan. The outcome of the Louisiana experiment is not known; nothing, at least, has since been seen of the insect where it was liberated. In the meanwhile this parasite was found attacking the black scale in Cape Colony by Mr. Lounsbury, who, at Dr. Howard's suggestion and with his assistance and the cooperation of different persons in California, notably Mr. Ehrhorn, succeeded in getting the parasite into California, where it has been installed under conditions which promise a successful introduction of the species. As reported by Mr. Lounsbury, the black scale in South Africa very rarely is abundant enough to be considered at all injurious, and this is apparently due to its parasitism by this little insect. If the latter can be successfully established in the orange and lemon groves of southern California, and if it maintains there the successful rôle that it does in South Africa, the saving in California will be second only to that accomplished by the Vedalia.

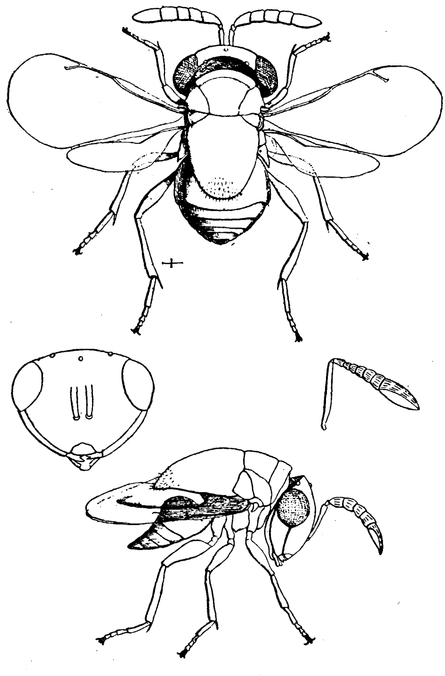

FIG. 22.—Imported chalcidid parasite of black scale (*Scutellista cyanea*), dorsal and lateral views—greatly enlarged (after Howard).

An account of the introduction of this species is given by Dr. Howard in Bulletins Nos. 17 and 26, new series, of the Division of Entomology. Fig. 22 is taken from a careful redescription of the parasite, published by Dr. Howard in "Rivista di Patologia Vegetale," in 1896.

The remedial treatments for the black scale are the oily emulsions and the gas treatment, discussed in the section on remedies.

### THE SOFT SCALE.

(*Lecanium hesperidum* L.)

This scale insect (fig. 23), also known as the turtle-back scale or brown scale, is closely related to the black scale just considered. It is, as its common name indicates, a much softer and more delicate insect than the black scale. It changes in color with age from a transparent yellow in the young to deepening shades of brown in the adult. The adult scale has a length of 3 or 4 millimeters, and is dark brown, turtle-shaped, and very much swollen, the body of the mother in the last stages becoming a mere cap filled with young. In the early stages the insect is thin and flat and semitransparent, almost, so that it is scarcely noticeable on the surface of the leaf or twig. The soft scale is very commonly found on various greenhouse plants, and has been carried to all parts of the world on such material, being now thoroughly cosmopolitan. In climates suitable for the growth of the orange and lemon it occasionally gains a foothold on outdoor plants. It has a gregarious habit, and commonly lives in colonies and frequently fairly plasters the young limbs and the midribs of the leaves. These colonies are usually not of long duration, being soon attacked and exterminated by parasitic and predaceous enemies, the soft texture of the insect not furnishing much, if any, protection. The transformation and habits are very similar to those of the black scale. It, however, is much more rapid in growth, and where the climate is favorable, as in greenhouses, goes through a continuous series of generations, or broods, throughout the season. It is infested by a very large number of parasitic flies and falls a ready prey to various predaceous insects, especially the different species of ladybirds. It readily yields to oily washes or to the gas treatment.

FIG. 23.—Soft scale (*Lecanium hesperidum*): Orange twig showing characteristic massing of the scales—natural size (after Comstock).


FIG. 24.—Hemispherical scale (*Lecanium hemisphæricum*): *a*, characteristic group of adult scales on olive—natural size; *b*, three female scales—considerably enlarged; *c*, scale lifted from leaf, showing mass of eggs (original).

THE HEMISPHERICAL SCALE.

(*Lecanium hemisphæricum* Targ.)

This scale (fig. 24) is also distinctively a greenhouse pest, and it can hardly be considered as especially injurious to citrus trees in orchards. It occurs all over the world, and occasionally will multiply to a slight extent on orchard-growing trees. It is about the same size as the last two species. In color, it ranges from light brown in the young to dark brown, changing to reddish in the old scale. The adult scale is hemispherical in shape, perfectly smooth and shiny, and this, with its color, readily distinguishes it from the other two species. The same remedies apply to it that are used against the black scale.

### THE FLORIDA WAX SCALE.

(*Ceroplastes floridensis* Comstock.)

This is a very curious and striking scale insect, which secretes a white waxy covering, arranged in a very regular geometrical pattern, as indicated in fig. 25. It was long known only from the peninsula of Florida, where it is undoubtedly native, its principal food plant being the gall berry, which grows abundantly in the "flat woods" and in the low ground about ponds. It has now been carried, however, to other parts of the world, notably some of the adjacent West Indian islands, and also to the Old World. It was imported into California on stock from Florida in 1889, and possibly earlier also, but has never gained any foothold on the Pacific coast. The insect thrives on various plants, including deciduous species, and often occurs on citrus plants, though rarely in sufficient numbers to be of very great importance. The white color and striking appearance of these scales cause them often to be noted, and very natural fears of damage are excited, but as a rule the natural enemies and other causes result in very few of the young reaching the adult stage. This, as shown by Mr. Hubbard, not only follows the action of parasites, but also is due to the fact that the scale lice as they become old and gravid can not maintain their hold on the smooth surface of the lemon or orange leaf and fall to the ground and perish. The citrus plants, therefore, are not especially adapted to this insect and very rarely suffer long or seriously from it.

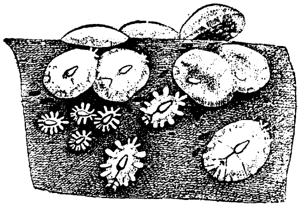

FIG. 25.—Florida wax scale (*Ceroplastes floridensis*): Group of scales, illustrating different stages of growth—enlarged about 4 diameters (original).

The Florida wax scale is three-brooded, development not being very rapid and extending over three or four months. The adult female insect, covered as it is with its waxy secretion, measures from 2 to 3 millimeters in length, is oval in form, and is characterized by a large central waxy prominence surrounded by six or eight smaller prominences, all, owing to the melting and cooling of the wax, much less distinctly limited than with the species to be next considered. The waxy secretions give an appearance to the young insect of an oval stellate object.

### THE BARNACLE SCALE.

(*Ceroplastes cirripediformis* Comstock.)

As given by Professor Comstock, this insect (fig. 26), which is closely allied to the last, has been found at two or three localities in Florida, notably at Jacksonville and in Volusia County, on orange and quince, and also on a species of Eupatorium. It is frequently associated on citrus plants with the Florida wax scale. It has since been found on the same and other food plants on some of the West Indian islands, notably Antigua and Jamaica, and in Louisiana and California. The barnacle scale is much larger than the Florida wax scale, having an average length of 5 millimeters and a width of 4 millimeters. The waxy covering is a dirty white, mottled with several shades of grayish or light brown, and the division of the waxy excretion into plates is distinct, even to a late age, there being visible a large convex dorsal plate and six lateral plates, as indicated in fig. 26. The development of the insect and secretion of the waxy scale covering is very similar to that of the last species described. The barnacle scale is of very little economic importance, and is mentioned merely because its presence might arouse suspicions of probable injury. The attacks of this and the preceding species in Florida, when at all severe, are apt to be followed by an invasion of the sooty fungus resulting from the secretion of honeydew. The sooty fungus, however, resulting from these insects is insignificant as compared with that following the white fly.

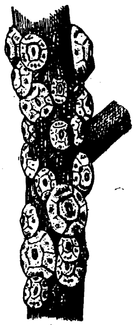

FIG. 26.—Barnacle scale (*Ceroplastes cirripediformis*): Group of scales on twig, illustrating different stages of growth—enlarged about 2 diameters (original).

### THE FLUTED SCALE.

(*Icerya purchasi* Maskell.)

Of all the scale insects attacking citrus plants, this species (figs. 27 and 28) is perhaps the most notable, not so much from the damage now occasioned by it as from the problems of control which it has brought to the front and the international character of the work which it has occasioned. The history of this very interesting species has been fully detailed in publications of this Department and elsewhere. The facts indicate that Australia is undoubtedly its original home, from whence it was introduced on Australian plants into New Zealand, Cape Town, South Africa, and California at about the same time. The evidence points to its introduction into California about the year 1868 by the late George Gordon, of Menlo Park, on *Acacia latifolia*. It spread rather rapidly throughout California, and by 1886 had become the most destructive of orange scale pests. The damage occasioned by it at that time and the years immediately following was of such a serious character as to threaten the entire citrus industry of the Pacific coast. The nature and habits of this insect made it almost impervious to any insecticide washes, and the citrus growers of California were rapidly losing heart.

In 1889, however, through the agency of Mr. Albert Koebele, a field assistant of the Division of Entomology, the natural ladybird enemy of the fluted scale in Australia was imported into California. This ladybird, *Novius* (*Vedalia*) *cardinalis* (fig. 29), multiplied prodigiously, and in a very short time practically exterminated the fluted scale, saved the State of California annual damage amounting to hundreds of thousands of dollars, and removed this scale insect from the roll of dreaded injurious species, no appreciable damage from it having been

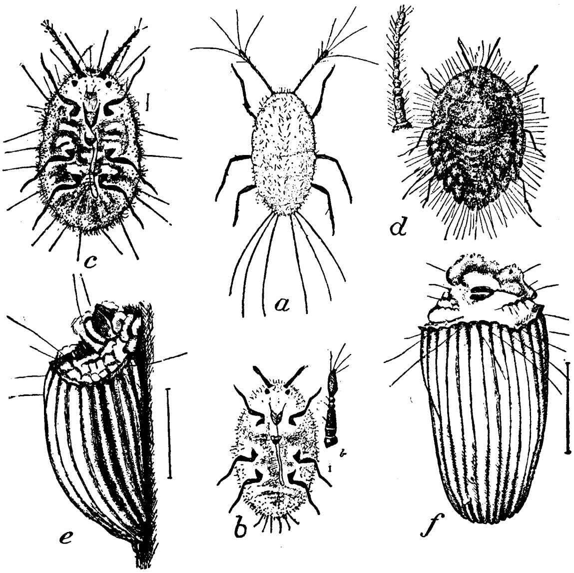


FIG. 27.—Fluted scale (*Icerya purchasi*), female series, illustrating the development of the female insect from young larva to adult gravid stage: *a*, newly hatched larva; *b*, second stage; *c*, third stage; *d*, full-grown female; *e* and *f*, same after secretion of egg sac—(original and after Riley).

suffered in that State for the last decade. All that is now necessary in California is to colonize a few of these ladybirds in any district where the fluted scale has gained a temporary foothold.

The beneficial results derived from this ladybird have not been confined to California. Through the agency of this Department and in cooperation with the California State authorities, this ladybird has been sent to South Africa, Egypt, and Portugal, and in each of these countries its introduction has been followed by similar beneficial results in the control of the fluted scale.

While the fluted scale, at the time or soon after its injurious record in California, gained access to several additional foreign countries, very fortunately Florida and the Gulf districts remained long free from it. A constant lookout was kept, however, and very often one or the other of the wax scales was sent to this office for the fluted scale. The first and presumably only introduction of this insect into Florida was brought to our notice in June, 1894. This was not a chance introduction, but, though not malicious, an intentional one, and illustrates the risk run in importations of beneficial insects undertaken by persons unfamiliar with the subject.

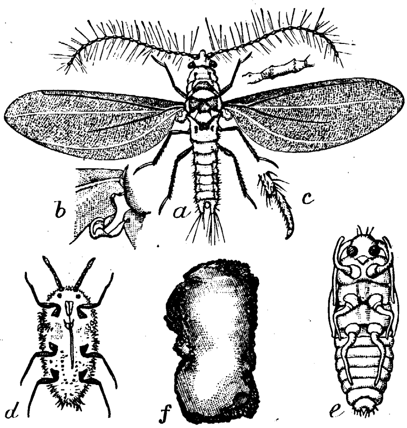

FIG. 28.—Fluted scale (*Icerya purchasi*), male series: *a*, male insect with greater enlargements of base of wing and foot at *b* and *c*; *d*, second stage of larva; *e*, pupa; *f*, cocoon—enlarged about 7 diameters (reengraved from Riley).

A nurseryman at Keene, Hillsboro County, Fla., having become acquainted with the wonderful work of the imported Australian ladybird against the fluted scale in California, became ambitious to have the same benefit duplicated against the common Florida scale insects; and, ignorant of the fact that the ladybird in question did not feed on any of the armored scales which he especially wished to have controlled by it, he got one of the county horticultural commissioners of California to ship him a lot of these ladybirds, together with some of the fluted scale as food. The whole lot was liberated on his premises and resulted, naturally enough, in stocking some of his trees very thoroughly with the fluted scale. The infestation coming to his attention, he sent specimens to the Division of Entomology and they were promptly determined as the dreaded California scale pest. Fortunately, the nurseryman in question realized the enormity of his offense and took, at Dr. Howard's earnest suggestion, immediate and active measures to exterminate the fluted scale on his premises. Very fortunately also, the winter following proved to be a severe one and, as he informed us subsequently, the cold resulted in the killing down of all the plants growing

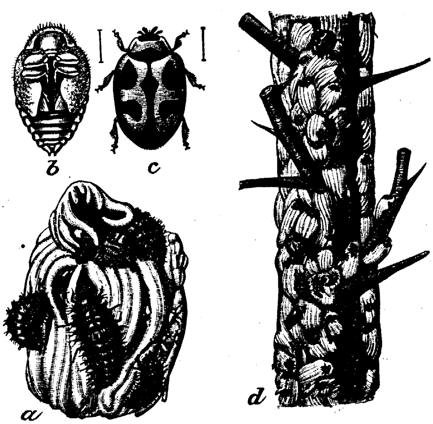

FIG. 29.—Australian ladybird enemy of the white scale (*Novius cardinalis*): *a*, ladybird larvæ feeding on adult female and egg sac; *b*, pupa; *c*, adult ladybird; *d*, orange twig, showing scale and ladybirds—natural size (author's illustration).

about where the scale was located, and the whole lot was taken out and burned. Nothing more was heard from this scale for nearly four years, and it was a reasonable conclusion that its complete extermination had been accomplished.

On December 3, 1898, specimens of the fluted scale were sent to the Division from the same general locality in Florida, with the statement that they occurred in several yards, mostly on rosebushes and cape jasmine, and in one or two orange groves in the neighborhood. It is evident, therefore, in spite of our hopes to the contrary, that the fluted scale has maintained itself in Florida during the intervening four years, although not multiplying very rapidly. In view of the quite general spread of this species in this region it seemed improbable that it could be easily exterminated, especially in the face of the failure of the previous attempt, and the immediate introduction of the Australian ladybird as a means of control was most urgently advised by Dr. Howard. This was undertaken by the newly appointed State entomologist of Florida, Mr. H. A. Gossard, working in conjunction with Mr. Alexander Craw, quarantine officer and entomologist of the California State Board of Horticulture, and during the spring of 1899 the ladybird in question was successfully colonized in two of the infested orchards, and, as reported by Mr. Gossard, by the midsummer of 1900 had become pretty thoroughly established and had already been distributed in some dozen infested localities.

The fluted scale in Florida evidently does not multiply as rapidly as it does in California, judging from its rather slow progress since its introduction in 1894. Furthermore, as shown by Mr. Gossard, it is attacked by a fungous disease which appears suddenly in July, and results in the death of from 25 to 70 per cent of the partly grown scales. We may hope that with the aid of this disease and by means of the prompt introduction of its natural enemy, the fluted scale will never play the rôle in Florida which it originally did in California.

The habits and transformations of the fluted scale illustrated in figs. 27 and 28 closely parallel those of the species of Lecanium already described. The general appearance of the insect, however, is strikingly dissimilar, owing to the waxy excretions from the ventral plate of the adult female insect. These are ribbed, or fluted, from whence the insect takes its name, and become the receptacle of a vast number of eggs, a single female being the possible parent of more than a thousand young. The fluted scale is extremely hardy, will live for some time without food, and can multiply and thrive on a vast number of food plants in addition to the various citrus varieties. The eggs are deposited by the female insect in the cottony egg sac already referred to, which begins developing when the gravid condition is assumed. The waxy material constituting this sac issues from countless pores on the under side of the body, especially along the posterior and lateral edges. As this secretion accumulates the body is lifted, so that ultimately the insect appears to be standing almost on its head, or nearly at right angles to the bark. The eggs are laid in the waxy secretion as it is formed, the waxy fluted mass often becoming from two to two and one-half times as long as the insect itself. The young are of reddish color, very active, and spread naturally by their own efforts and by the agency of the winds, birds, and other insects. The partly grown and adult female insect is, for the most part, a reddish orange, more or less spotted with white or lemon, sometimes a dirty white or pea greenish, the coloration being partly due to waxy excretions and to the extraneous matter taken up from the surface of the plant.

The early stages of the male are similar to the corresponding stages of the female. Before appearing as an adult, the male insect secretes itself in some crack in the bark, or in the ground, leaving the tree, and exudes a waxy covering, which forms a sort of cocoon, in which the transformations are undergone, first into the pupa and then into the adult or perfect insect. The winged male insect is rather large for a Coccid, and has a reddish body with smoky wings and the general structural features indicated in fig 28.

The rate of growth of the fluted scale is comparatively slow, and it does not normally have more than three generations annually. This insect is much more active than most other species which have the power of motion throughout life, and the female travels and moves about very freely nearly up to the time when she finally settles for oviposition and the development of her egg sac. The male is active up to the time when it settles down to make its cocoon.

The fluted scale exudes a great quantity of honeydew, and trees badly attacked by it are covered with the sooty fungus, characteristic of the black scale and the white fly.

The remedy for this scale insect is always and emphatically to secure at once its natural and efficient enemy, the *Novius cardinalis*. Where this insect can not readily be secured, the scale may be kept in check by frequent sprayings with the kerosene or resin washes. Fumigation is comparatively ineffective against it, because the eggs are not destroyed by this treatment. Spraying is, for the same reason, effective only when it is repeated sufficiently often to destroy the young as they hatch.

### THE COMMON MEALY BUG.

(*Dactylopius citri* Risso.)

The common mealy bug of the orange and other citrus plants is especially destructive in Florida and the West Indies. It is not of much importance in California. This species (fig. 30) is more commonly known, perhaps, as the destructive mealy bug, from the name given to it by Professor Comstock of *Dactylopius destructor*, descriptive of its abundance and destructiveness in orange groves in Florida.

It occurs very commonly in greenhouses, and has been carried to every quarter of the globe, both on greenhouse plants and on various subtropical plants grown out of doors. The insect is mealy white in color, the female attaining a length of nearly a quarter of an inch when fully adult. The edge of the body is surrounded by a large number of short waxy filaments, as indicated in fig. 30. The habits of this species closely resemble those of the white or fluted scale, in that it is active at practically all stages and that the eggs are laid in and protected by a cottony or waxy secretion, the female insect as this is developed being gradually forced from the bark and standing almost on her head, as in the case of the former species. The adult winged male is light olive brown.

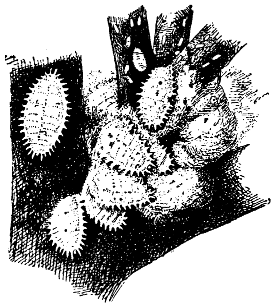

FIG. 30.—Mealy bug (*Dactylopius citri*): Mass of insects at fork of leaf, showing different stages and cottony excretion covering eggs—enlarged 4 diameters (original).

This species is somewhat gregarious, and occurs in masses in the angles of the branches and leaf petioles and about the stem of the fruit. The remedies are the emulsions and oily washes, repeating them as often as necessary to reach the young as they hatch.

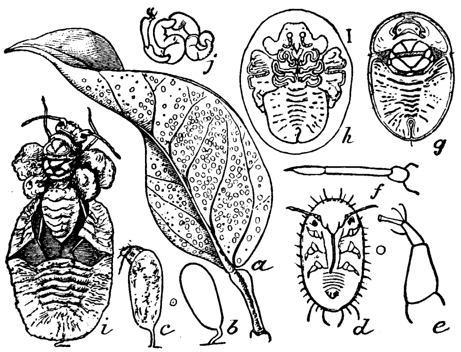

FIG. 31.—White fly (*Aleyrodes citri*): *a*, orange leaf, showing infestation on under surface—natural size; *b*, egg; *c*, same, with young insect emerging; *d*, larval insect; *e*, foot of same; *f*, larval antennæ; *g*, scale-like pupa; *h*, pupa about to disclose adult insect; *i*, insect escaping from pupal shell; *j*, leg of newly emerged insect, not yet straightened and hardened—all figures except *a* greatly enlarged (reengraved from Riley and Howard).

## IMPORTANT CITRUS PESTS OTHER THAN SCALE INSECTS.

### THE WHITE FLY.

(*Aleyrodes citri* Riley and Howard.)

The white fly of Florida and the Gulf region (figs. 31 and 32) is, strictly, not a scale insect, but belongs to a closely allied family. In general appearance and habits, however, at least in its economic features, it exactly duplicates the true scale insects, and would be classed with them by every nontechnical observer. For many years this very interesting insect has been known to infest the orange trees of Florida and Louisiana, and also to be a common pest on the orange in greenhouses. It has been found also on a number of plants other than orange, such as viburnum, cape jasmine, and the aquatic oak of the South. These other food plants are of significance only in indicating that it may be harbored in situations near orchards in which efforts have been made to exterminate it. The first careful description of this insect and general account of its habits was given by Riley and Howard in 1893, and from their article the data following are largely derived.

The white fly is limited, economically, to the citrus plantings of Florida and the Gulf region. It is widely distributed in greenhouses, as already noted, and has undoubtedly been carried to California on many occasions, but has never assumed any importance on the Pacific coast.[1] Its origin is unknown. It first came into prominence about 1885, but probably had been present in greater or less numbers for a much longer period, and perhaps is native to Florida, nominally subsisting on some wild food plant.

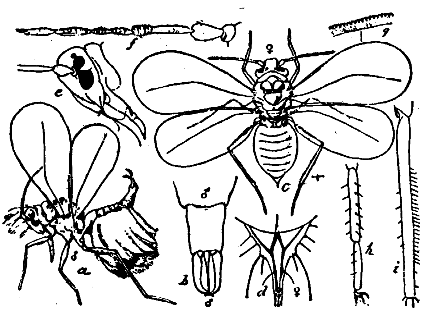

FIG. 32.—White fly (*Aleyrodes citri*): *a*, winged male insect, with enlarged view of terminal segments at *b*; *c*, dorsal view of winged female, with enlargements of ovipositor, head, antenna, wing margin, and leg at *d*, *e*, *f*, *g*, *h*, *i* (reduced from Riley and Howard).

While closely resembling a scale insect in its early stages, the white fly in the adult stage emerges, in both sexes, as a minute white gnat, having four chalky wings of a fine glandular texture, from which fact it is frequently called the "mealy wing." This active adult condition gives the white fly a distinct advantage over scale insects in means of spread.

The damage occasioned by it is due, perhaps only secondarily, to the sapping of the vital juices of the plant, which, however, must be considerable, since it multiplies enormously and often covers the under surface, especially of the leaves, so that the insects fairly overlap. The main injury, however, is due to the secretion by this insect, in the larval and pupal stages, of a honeydew similar to that secreted by the true scale insects. This secretion is in enormous amount, and the sooty mold which develops in it frequently covers the entire upper surface of the leaves and produces very serious effects on the vitality of the plant. Frequently the assimilation by the plant of nourishment through the leaves is almost entirely stopped. The growth of the plant becomes greatly checked, the fruit does not ripen properly, and is deficient in quality and size and keeps poorly, involving in addi-

[1]Recent press reports (February, 1901) indicate that the white fly has been found in various citrus districts about Los Angeles. If this be true, this insect in favorable seasons may prove in the future a serious pest in southern California, but in the main it will probably not be able to withstand the dry climate, and will probably never be as troublesome in California as it is in Florida and Louisiana.

tion the expense of washing before it can be marketed. In Florida the sooty mold is produced almost altogether by this insect, although following to a certain extent the attacks of some species of scale insects, as already noted, the damage being quite as great in Florida from the white fly as in California from the black scale.

The general character of the egg, larval, and adult stages are clearly shown in figs. 31 and 32. The life round of the insect, briefly, is as follows: The winter is passed in the mature larval stage as a thin, elliptical, scale-like object on the under sides of the leaves. Early in the spring the transformation to the pupal stage occurs, this stage differing but slightly from the larval in appearance. The adults begin to appear by the middle of March and continue to emerge into April. The eggs deposited by this brood require about three weeks for development, hatching into larvæ from the middle of April to the first of May. The adults of the second brood begin to emerge by the middle of June and continue to appear until the middle of July. Between the middle of July and the middle of September a third brood is developed, the larvæ of which, hatching about the last of October, carry the insect through the winter. The number of eggs laid by a single female is in the neighborhood of twenty-five, and they are placed, by preference, upon new leaves, but all of the plant is taken when the multiplication of the insect makes it necessary. The young larva is active, resembling closely the larva of a true scale insect. The life of the adult ranges from ten to twenty days.

The most satisfactory remedies for this insect, as demonstrated by the experiments of Messrs. Swingle and Webber, are the kerosene and resin washes. The treatments may best be made during the winter, between December and March, and again, if necessary, in May, and also in August or early in September. Two or three applications may be made in the winter. The application in August is made if the sooty mold is found to be spreading to the fruit. Since the insect lives on the under sides of the leaves almost exclusively, it is of prime importance to see that the under surface is thoroughly wetted with the spray, and to be at all effective it is necessary that the tree be opened up by pruning. Fumigation with hydrocyanic-acid gas is also a ready means of destroying this insect. It is undoubtedly kept more or less in check by parasitic and predaceous enemies, and is subject to attack by several fungous diseases, which may be of occasional value in preventing its undue multiplication.

### THE RUST MITE OF THE ORANGE AND THE SILVER MITE OF THE LEMON.

(*Phytoptus oleivorus* Ashmead.)

As indicated by the common names applied to this insect, it is an enemy of both the orange and lemon, affecting these fruits in a somewhat different way. It attacks, also, the other members of the citrus family, but has never been observed on other plants. For many years this mite (Pl. XXXI) was known only in Florida, and its injuries were notable only in the case of the orange. The fact that it was not originally found on the wild orange, would seem to indicate that it may have been an introduced species, but there is no evidence of its having come to Florida from any foreign country, and it seems reasonable to believe that it is probably native to the Florida peninsula, possibly having originally some food plant other than the orange.

The lemon and orange groves of California were for a long time entirely free from the attacks of this mite, but about 1889 some carloads of citrus trees were taken into California from Florida and planted, without careful inspection, in the Rivera and San Diego Bay districts. This shipment of trees brought with it, unfortunately, two or three of the Florida scale insects, and also this rust mite, which has gained a foothold in the important lemon districts about San Diego, and is now one of the worst pests the lemon grower has to deal with. For a number of years the effect of its attacks on the fruit of the lemon in California was ascribed to a fungous disease, and it was not until the writer visited the lemon districts about San Diego Bay in 1896, and identified the injury as due to the Florida rust mite, that its true nature was known.

This mite develops on both the leaves and fruit, although its presence on the former is often overlooked. On the foliage the presence of the mite causes the leaves to lose their gloss and become somewhat curled, as though by drought. The leaves are never killed, however, and their functions are not entirely impaired, the attack resulting merely in the considerable checking of the vigor of the plant.

The results of the presence of this mite on the fruit of the lemon are slightly different from its effect on the fruit of the orange. The ripening fruit of the orange after having been attacked by the mite becomes more or less rusted or brownish, and the rind is hardened and toughened. The result is that, while the orange loses its brilliant fresh color and gloss, the toughening and hardening of the rind enables the fruit to stand long shipment, and protects it very materially from decay. It was further found that the quality of the juice was rather improved by the mite than otherwise, the mite-attacked oranges being more juicy and sweeter flavored than those free from it. As a result of this, a demand grew up in the Northern markets for the rusty fruit, and good prices were obtained for it.

In the case of the lemon, however, an injury to the rind is an important consideration, a perfect rind being a requisite of the fruit on account of the numerous uses to which the rind is put and the valuable products obtained from it. The effect on the lemon is also somewhat different from that on the orange. The rind of both fruits, when attacked by this mite in the green stage, becomes somewhat pallid or


THE SILVER MITE OF THE LEMON.
(PHYTOPTUS OLEIVORUS ASHM.)

"silvered," due to the extraction of the oils and the drying up and hardening of the outer layer of the skin. In the case of the lemon, however, this whitening is much more marked than in the case of the orange, and, since the lemon is often picked while green, the subsequent rusting is not nearly so notable; hence, in California this mite is known chiefly as the silver mite. If the lemon is allowed to fully ripen on the tree, however, it becomes bronzed or rusted, similar to the rust of the orange, but rather lighter in shade. (See Pl. XXXI.)

As in the case of the orange, the rind of the lemon is hardened and toughened, but the juicy contents are not affected materially; furthermore, a silvered lemon will keep very much longer than a perfect lemon, and will bear distant shipment without risk of much loss. Up to the present year the rusted lemon in southern California has found no market whatever, and has been a total loss to the grower. The scantiness of the crop of lemons in 1900 resulted, however, in such demands for this fruit that some shipments were made of rusty fruit under the name of "russet lemons," about half the normal price being obtained. Should the manufacture of citric acid assume very much importance in southern California, the mite-injured lemons could be used for this purpose. Nevertheless, considering the ease with which the mite may be controlled, one has no excuse for allowing it to maintain itself in injurious numbers in a lemon grove, since, irrespective of the appearance and value of the fruit, its work on the foliage materially checks the healthfulness and vigor of the plant.

The rust mite avoids exposure to sunlight, and hence the lower half of the fruit is nearly always first invaded, and only gradually does the mite work its way around to the upper surface, very frequently a small portion exposed to the direct rays of the sun remaining unattacked. This gives the appearance, most prominently shown in the case of the orange, of a discolored band extending about the fruit, irregularly limiting the area over which the mites have worked. The multiplication of this mite goes on at all seasons of the year in the orange and lemon districts, being merely less prolific and active in winter than in summer. It has been supposed in Florida that dry weather is inimical to it, but the fact that it thrives in southern California would seem to throw doubt on this belief.

The rust mite itself is very minute, practically invisible to the naked eye, except to the very sharpest vision. It is honey-yellow in color, and about three times as long as broad. It is provided with four minute legs at its head extremity, by means of which it drags its worm-like body slowly after it when it moves from one spot to another. The general features and structure of the mite are shown on Pl. XXXI. The eggs are circular and are deposited singly or in little clusters on the surface of the leaf or fruit. They are about half the diameter of the mother and nearly transparent in color, having, however, a slight yellowish tinge. They hatch in four or five days in hot weather, but in cold weather the development of the embryo may be delayed for one or two weeks. The newly hatched mite is very similar to the adult. About a week after hatching it undergoes a transformation, or moult, requiring a period of about forty-eight hours, after which the regenerated mite escapes from the old skin, which remains adhering to the leaf or fruit for some little time. This moult brings the mite to its adult stage, in which it is somewhat darker in color than the young, and becomes opaque as soon as it reaches full maturity. No sexual differences have been discovered, and the number of eggs deposited by a single mite is not known. The entire development of the mite is short, probably not much exceeding, in warm weather, two weeks.

The food of the mite seems to be the essential oil which is abundant in all the succulent parts of citrus plants, and which is obtained by the mites by piercing the oil-cells with their beaks, resulting, as noted, in the hardening and death of the outer epidermis and the accompanying changes in color.

These mites, while excessively minute, are capable of very active locomotion, and, as estimated by Hubbard, their rate of progress over a smooth surface, if continuous, would amount to 10 or 12 feet per hour. They are, at any rate, able to change their location with apparent rapidity, moving from one part of the leaf to another, as the conditions of light and food necessitate.

Some very interesting calculations were made by Mr. Hubbard as to the number of these mites which might occur on a single leaf. His counts were made in the autumn, when the mites are much less numerous than in the summer. His estimate, made from actual count, indicates that the number of mites and eggs on a single leaf in midwinter may reach the enormous sum of 75,000. This indicates for trees in the active breeding season of summer billions of mites. The mite is very readily distributed by means of insects and birds.

As shown by very careful experiments conducted by Mr. Hubbard, the rust mite is readily destroyed by various insecticides. The eggs, however, are much more difficult to kill, and practically no wash which will not greatly injure the tree can be relied upon to destroy all the eggs of this mite. Experience in California indicates that gassing is also ineffective against the eggs. The sovereign remedy for the rust mite is sulphur, this substance destroying adults with great readiness. It may be applied as a powder on trees, and, moistened by rain or dew, will adhere to the leaves for quite a long period, not being readily washed off even by a hard rain. When spraying is done for scale insects the flowers of sulphur can be mixed up and applied with the spray at the same time, accomplishing both purposes at once. In California the writer in this manner combined the distillate spray and also the kerosene-emulsion spray with sulphur dissolved with lye. The flowers of sulphur can be used in the same way without any attempt at dissolving it. Almost any insecticide will kill the adult mite, such as kerosene emulsion, resin wash, or even a simple soap wash, but unless the eggs are killed the trees will be reinvaded about as thickly as ever in the course of a week or ten days. The advantage of the sulphur treatment arises from the fact that the sulphur adheres to the leaves and the young mites are killed as soon as they come in contact with it.

### THE SIX-SPOTTED MITE.

(*Tetranychus sexmaculatus* Riley.)

The leaf mite or spider of the orange and lemon (fig. 33) is very closely allied to the common red spider of greenhouses. It first made its appearance as an important orange pest in Florida in 1886. Following the severe freeze of the winter of 1885–86 in Florida, the weakened trees seemed to be especially favorable for the multiplication of this mite; it increased suddenly in enormous numbers during the dry weather of the early summer of 1886 and was responsible for very considerable damage to the foliage of the orange.

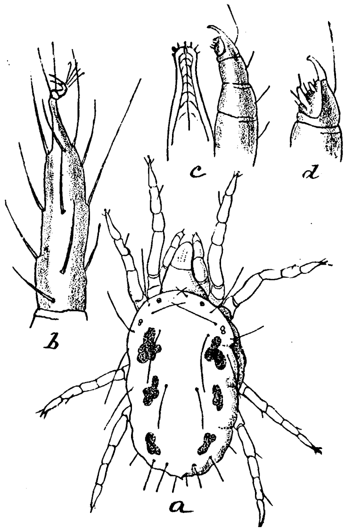


FIG. 33.—Six-spotted mite of the orange (*Tetranychus sexmaculatus*): *a*, dorsal view of adult mite—vastly enlarged; *b*, greater enlargement of foot; *c*, *d*, mouth parts (from "Insect Life").

The original food plant of this mite is unknown. It was first noted on wild, or sour, orange, from which it spread to other citrus trees. There is no reason for believing it not to be a native of Florida, and it is not improbable that it may have several wild food plants.

Like its allies, it is greatly influenced by climatic conditions, and needs for its excessive multiplication dry, hot weather. Therefore, in rainy seasons it is not especially troublesome, and it usually promptly disappears almost completely as soon as rainy weather sets in. In Florida, this means a disappearance during the rainy season, which usually comes in June or July, its period of greatest destructiveness falling between February and the middle of May. This mite was carried to California a decade or more ago with Florida stock, doubtless at the same time that the other Florida citrus insects were transported to the Pacific coast. It has since been recognized as an injurious species in the lemon and orange districts of southern California, occasionally multiplying in sufficient numbers to be troublesome.

The attacks of this mite are confined largely to the under sides of the leaves, which are covered with a fine web, beneath which the mite feeds. The first indication of its presence is usually a yellowing in streaks and spots of the upper surface of the leaves. The under surface becomes soiled by the accumulated excrements in the form of minute black spots and by the web of the mite. In the case of badly attacked trees the foliage curls and shrivels and finally may even fall, the trees losing half or more of their leaves, and similarly also a large percentage of the half-formed fruit. Being an accompaniment of drought in Florida, part of the damage may undoubtedly be ascribed to the effect of the dry weather.

This mite is apt to be injurious in the case of weakened trees, as already noted, but with vigorous growing plants is rarely very harmful.

The remedies for this mite are the same as for the rust or silver mite. Flowers of sulphur, either as a dry powder or in the form of a spray, is a most effective remedy. The bisulphide of lime is also an effective wash against this mite. It can be made very cheaply by boiling together in a small quantity of water equal parts of lime and sulphur. Five pounds of lime and 5 pounds of sulphur, dissolved by boiling, should be diluted to make 100 gallons of spray.

# HOW BIRDS AFFECT THE ORCHARD.

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## INTRODUCTION.

That birds sometimes inflict injuries upon orchard trees and their products is a fact with which every fruit grower is familiar; but it is not so well known that they are frequently of great service in destroying enemies of the orchard, and yet the aid they render in this subtler way far more than offsets the harm that is so apparent.

The enemies with which the fruit grower has to contend, aside from the elements and the birds themselves, may be divided into three categories: Vegetable parasites, such as fungi and bacteria; certain mammals, such as rabbits and mice; and insects of various kinds. Against vegetable foes birds afford little, if any, protection. Their efficiency is shown in the destruction of noxious mammals and insects. The value of their work in dollars and cents is difficult of determination, but careful study has brought out much of practical importance in ascertaining approximately to what degree each species is harmful or helpful in its relation to the orchard.

## SOME BIRDS IMPORTANT TO THE FRUIT GROWER.

### WOODPECKERS.

Among birds which most directly affect the interests of the fruit grower may be mentioned woodpeckers, of which about 45 species and subspecies are found within the limits of the United States, all of decided economic importance. Their subsistence is obtained for the most part upon trees, a mode of life for which they are specially adapted. The character of the feet and tail enables them to cling easily to upright trunks, and the structure of the bill and tongue gives them the power to cut into solid wood and withdraw the insects lodged inside. The toes are in pairs, one pair projecting forward and the other backward, and are furnished with very strong, sharp claws, an arrangement which insures a firm hold upon the bark. The tail is composed of very stiff feathers pointed at the end, that can be pressed against the tree trunk, and thus made to support and steady the bird. The beak is rather long, but stout, and furnished with a chisel-shaped point, which is hardened and sharpened so as to render it a most effective wood-cutting instrument. The tongue, the most peculiar portion of the anatomy of these birds, is extended backward by two slender, flexible filaments of the hyoid bone, each incased in a muscular sheath (fig. 34, *a*). These filaments, instead of ending at the back of the mouth, curve up over the back of the skull, across the top of the head, and down on the forehead, and in some species enter the opening of the right nostril, and extend forward to the end of the beak (fig. 35). In the last case the tongue is practically twice the length of the head. By means of its surrounding muscular sheath, the tongue can be protruded from the bird's mouth a considerable portion of its length, and can thus be inserted into the burrows of wood-boring larvæ. In order to secure grubs or other insects, it is usually furnished with a sharp point and is barbed on the sides (fig. 34, *b*). It is evident that a bird possessing such an apparatus must be capable of doing work which less advantageously endowed species can not accomplish. Hence, while most birds content themselves with eating such insects as they find upon the surface, woodpeckers seek those larvæ or grubs which are beneath the bark, or even in the very heart of the tree. To render more effective the mechanism here described, these birds are gifted with a remarkably acute sense of hearing by which to locate their prey within the wood. That they do so with great accuracy, is disclosed by examination of their work, which shows that they cut small holes directly to the burrows of the grubs.

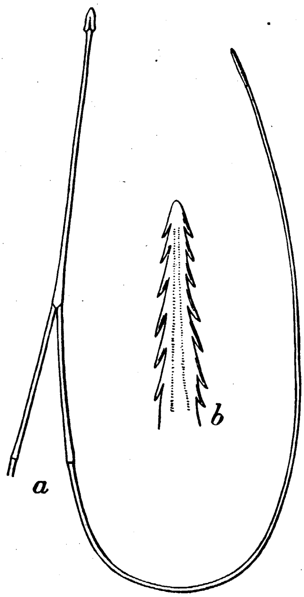


FIG. 34.—Tongues of woodpeckers: *a*, hyoid of flicker (*Colaptes auratus*); *b*, tip of tongue of downy woodpecker (*Dryobates pubescens*).

DOWNY WOODPECKER.—Of the various species of woodpeckers in the Eastern States, the two most important are the so-called downy and hairy woodpeckers. These birds are especially given to foraging in orchards, more particularly in winter; for, unlike most species, they do not migrate, but remain on their range the year round.

A study of the contents of the stomachs of many specimens of the downy woodpecker (*Dryobates pubescens*) shows that nearly one-fourth of the yearly food consists of ants. A celebrated French writer upon popular natural history has spoken of the ant as "the little black milkmaid, who pastures her green cows in the meadow of a rose leaf." This is a graphic, if somewhat fanciful, picture of the relations of ants and plant lice (Aphidæ); but unfortunately the black milkmaid does not limit her pastures to the rose-leaf meadows. There are comparatively few plants which do not suffer to some extent by the ravages of plant lice, and fruit trees and ornamental shrubs seem to be more especially subject to their attacks. Ants protect these plant lice from harm, and, when the plant on which they are feeding is exhausted, carry them to fresh pastures, and in some cases actually build shelters over them. Besides destroying the ants, the downy woodpecker eats many of the plant lice.

Again, when the woodpecker has, by its keen sense of hearing, located the larva of a wood-boring beetle in a tree, and dislodged it with the aid of the sharp-edged chisel and probe, there is much likelihood that the next time it visits the tree it will find a colony of ants snugly established in the burrow of the defunct grub, whose somewhat limited quarters they are extending in every direction. It now brings to bear upon the ants the same apparatus it used in the case of the grub, and they are soon drawn out and devoured. From these two sources are obtained the ants that are found in the food of this bird, and that constitute 23 per cent of that food. In both cases the insects are harmful, and the woodpecker stops the injury and benefits the tree.

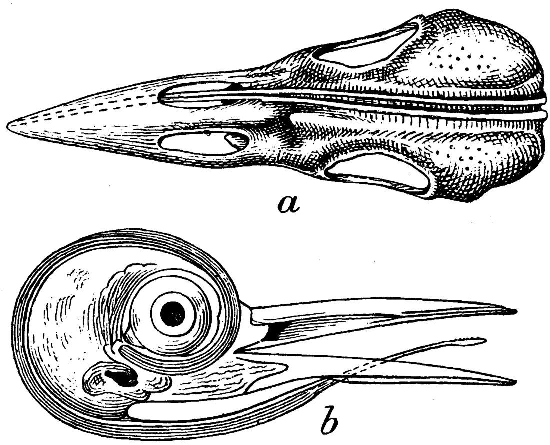


FIG. 35.—Special development of tongues of woodpeckers: *a*, skull of flicker (*Colaptes auratus*), showing root of tongue extending to tip of bill (after Lindahl); *b*, head of hairy woodpecker (*Dryobates villosus*), showing root of tongue curving around eye (after Audubon).

Of the food of the downy woodpecker, 13 per cent consists of wood-boring coleopterous larvæ, insects that do an immense amount of damage to fruit and forest trees, and are, as stated, protected from the attacks of ordinary birds by their habit of burrowing in trees. Besides the grubs taken from within the wood, the woodpecker eats many of the parent insects from whose eggs these grubs are hatched. It also destroys numerous other species that live upon the foliage and bark. Caterpillars, both those that bore into the tree and those that live upon the leaves, constitute 16 per cent of its food, and bugs that live on berries and give to them such a disagreeable taste form a considerable portion of its diet. Bark lice or scale insects (Coccidæ), pests of the worst description, are also eaten by this bird, and to an extent that is surprising when their minute size is considered.

HAIRY WOODPECKER.—The hairy woodpecker (*Dryobates villosus*, fig. 36) subsists on food that is similar in general to that of the downy; and although it does not eat quite so many ants, it destroys more beetle larvæ and more caterpillars, and thus renders quite as good service in the orchard. In winter, birds of both these species are more pressed for food than in summer, and may be seen busily searching the crevices in the bark, where they find hibernating insects and insects' eggs. By devouring these they destroy many enemies that would have attacked the trees at the approach of warm weather.

FIG. 36.—Hairy woodpecker (*Dryobates villosus*).

FLICKER.—The flicker (*Colaptes auratus*, fig. 37), another member of the woodpecker family, is well known to most orchardists and farmers. It is larger than either the downy or the hairy woodpecker, and differs somewhat from them in its food habits. It eats fewer beetles and caterpillars, but devours an enormous number of ants. Two stomachs were examined, each of which contained more than 3,000 ants, and in a third were 5,000, of a very minute species. Not all of these ants, however, are obtained from trees; many are species that burrow in the earth, for the flicker is more terrestrial than most of the other woodpeckers, and takes much of its food from the ground.

FIG. 37.—Flicker (*Colaptes auratus*).

YELLOW-BELLIED WOODPECKER.—On the other hand, some harm to fruit trees is to be charged against this family, though there is much popular misapprehension in this regard. The smaller species have been called sapsuckers, from the supposition that they puncture holes in the bark of trees in order to get the sap and soft inner bark. The charge is well grounded, but only one species, so far as known, causes any appreciable harm through the practice. This is the yellow-bellied woodpecker (*Sphyrapicus varius*, fig. 38), whose summer range is confined to Canada, the northern portions of the United States, and the Allegheny Mountains, and whose winter residence is in the Southern States. This bird is injurious to certain trees, at times removing the outer bark over a considerable area, and at others pecking numerous holes very close together, in each case practically girdling the tree. As the sap collects in the pits thus formed, the bird drinks it, and also catches the insects that are attracted to the pits by the sweetness

FIG. 38.—Yellow-bellied woodpecker (*Sphyrapicus varius*).

of their contents. The trees attacked, mostly birches, mountain ashes, maples, and apple trees, often die the first or second year after the girdling is done. Fruit trees, however, are not very frequently attacked by this bird, and the species is not numerous enough to cause any perceptible harm to the forest. Examination of the stomachs of yellow-bellied woodpeckers shows that alburnum, or the soft tissue lying between the inner layer of bark and the hard wood of the tree, constitutes quite an important item of the diet, 23 per cent of the food of the year. Other woodpeckers also eat sparingly of the same substance, but the little they take is of no practical importance.

RED-BELLIED WOODPECKER.—The red-bellied woodpecker (*Melanerpes carolinus*), which is not common in the East north of Pennsylvania, has fallen into disrepute among the orange growers of Florida by its attacks on oranges. It does considerable damage by pecking holes in the ripe fruit, and sometimes causes serious loss. It is to be hoped that experience will show some way to prevent these ravages without destroying the bird, for its harmfulness is confined to the orange groves of Florida, and it is of much value elsewhere.

OTHER WOODPECKERS.—The other woodpeckers, both eastern and western, are all more or less useful to fruit raisers. In the West and South, besides several subspecies of the hairy and downy woodpeckers, are other members of the same genus (*Dryobates*), which have food habits, as shown by stomach examination, that closely approximate those of the hairy and downy. These include the red-cockaded (*D. borealis*), Texan (*D. scalaris bairdi*), St. Lucas (*D. scalaris lucasanus*), Nuttall's (*D. nuttalli*), and Arizona (*D. arizonæ*). Several woodpeckers belonging to the genus *Picoides*, that inhabit the northern part of the country and beyond, are equally useful. The genus *Melanerpes*, with its half dozen species, covers practically the whole United States, and, like the genus *Dryobates*, is a group of useful insectivorous birds, with the possible exception noted above. In the West three species of flickers are found whose food is practically the same as that of the eastern species.

## TITMICE.

BLACK-CAPPED CHICKADEE.—The well-known titmice, or chickadees, though small in size and unobtrusive in habits, do much good in both orchard and forest. So far as known, the food habits of all are beneficial. The winter food of the familiar black-capped chickadee (*Parus atricapillus*), which has been investigated by Prof. Clarence M. Weed,[1] of New Hampshire, and by the Biological Survey, consists of noxious insects, and more especially of insects' eggs. The eggs of plant lice (Aphidæ) were found in a large proportion of the stomachs examined, and constituted an important percentage of the food. Besides these,

[1] Bulletin 54, N. H. College Agr. Exp. Sta., June, 1898.

the eggs of such pests as the common tent caterpillar (*Clisiocampa americana*), the forest tent caterpillar (*C. disstria*), and the fall cankerworm (*Anisopteryx pometaria*) are eaten. In winter chickadees spend most of the daylight hours in searching trunks and branches of trees, inspecting every crevice in the bark and examining every bud for the insects' eggs and hibernating insects, which constitute so large a part of their food.

Mr. E. H. Forbush, ornithologist to the Massachusetts State board of agriculture, has shown how these birds may be attracted to the orchard in winter by hanging up pieces of suet, or bones with a little meat still attached to them.[1] In this way they are induced to leave the woods and live in the orchard during the winter, and finally to build their nests and rear their young there.

CALIFORNIA BUSH-TIT.—Other species of titmice are quite as useful as the black-cap. Examination of the stomachs of a number of California bush-tits (*Psaltriparus minimus*) revealed the presence in considerable number of the black scale (*Lecanium oleæ*), which infests the olive. This insect has been a serious pest to the olive trees on the Pacific coast, and any bird that will destroy it should certainly be encouraged by Western fruit growers. The usefulness of titmice depends largely upon the small size of the birds. In dealing with pests of any kind, the more minute they are the less the probability that man can by his own unaided efforts succeed in exterminating them. Plant lice and bark lice are, on this account, difficult of destruction by human agency, and are too small to attract the attention of many of our ordinary birds; but to the chickadees they must appear of considerable size, and so are easily found and eaten. The eggs of insects, especially those of such small species as plant lice, are often so minute as to escape the closest search by man; but the more microscopic eyes of these small birds detect them even in crevices of buds or bark.

### NUTHATCHES AND CREEPER.

Frequent associates of the chickadees, and doing practically the same work, are the nuthatches and the brown creeper. The nuthatches are of about the same size as the chickadees, but are more agile tree climbers, in this respect excelling all other North American birds. While woodpeckers and titmice usually run up the trunks, nuthatches run up or down, or along the underside of a horizontal branch, with equal facility, and do not depend upon the tail for support. The brown creeper, like the chickadee, is constantly engaged during the day in searching for insects' eggs and small insects in the crevices of the bark. It is an active, nervous little creature, which flits rapidly from one tree to another, generally alighting upon the trunk near the

[1] Mass. Crop Reports, p. 349, 1895.

base, then running spirally upward, and, after a hurried inspection, winging its way to the next tree. These three birds perform a service which it is difficult for man to do for himself, and they should be protected and encouraged.

CUCKOOS.

Probably no group of insects contains a greater number of orchard pests than the order Lepidoptera, which comprises butterflies and moths, with their larvæ, or caterpillars. Tent caterpillars, cankerworms, fall webworms, tussock moths, codling moths, and a host of others are among the worst enemies of the fruit grower. It is, therefore, fortunate that there are in the United States two birds that subsist, to a great extent, upon caterpillars, apparently preferring them to any other food. These are the cuckoos, the yellow-billed (*Coccyzus americanus*) and the black-billed (*C. erythrophthalmus*). For years it has been a matter of common observation that these birds feed largely on caterpillars, but, until a number of stomachs had been examined, it was not known how great a proportion of their food is made up of these harmful insects. The examinations indicated that caterpillars of various species, including some of the most destructive, constitute more than 48 per cent of their food. One stomach contained at least 250 tent caterpillars, probably a whole colony, in the young stage. In another 217 heads of the fall webworm (*Hyphantria cunea*) were counted, and this probably fell far short of the real number, as these larvæ are very small, and in many instances nothing but jaws remained undigested. In the stomachs of 155 cuckoos taken in various parts of the country were found 2,771 caterpillars of various species, or an average of 18 to each stomach. When we consider that a caterpillar is so soft and easily digested that soon after being swallowed it has entirely passed from the stomach, it is evident that in one day far more than this number (18) must have been eaten by the average bird. Many caterpillars are protected from the attacks of birds and parasitic insects by a covering of hair, and hairy caterpillars are only rarely eaten by most birds. Cuckoos, however, seem to prefer them to the smooth kind, and apparently eat them whenever they can be found. Caterpillar hairs are often stiff, bristly, and sharp at the end, like minute thorns, and it frequently happens that when a cuckoo's stomach is opened and emptied it is found to be completely furred on the inside by hairs which have pierced the inner lining and become fast. Cuckoos eat many noxious insects besides caterpillars, such as beetles, bugs, and grasshoppers. Unfortunately, they are naturally rather shy birds, preferring the edges of woodland and groves to the more open cultivated grounds and orchards. If, however, they are unmolested, they soon gain confidence, and in many cases frequent shade trees about houses and lawns, or even in the very heart of the city.

### BALTIMORE ORIOLE.

The Baltimore oriole or golden robin (*Icterus galbula*) also feeds largely on caterpillars, which amount to 34 per cent of its summer food. When nesting, the oriole may be seen searching among the outer twigs of trees, examining every leaf in quest of its favorite food. In addition to caterpillars, it destroys many noxious beetles and plant and bark lice. But its reputation is not unblemished. Some complaint has been made against it by fruit growers, and John Burroughs accuses it of destroying grapes. However, its peculations of this character are probably not very great, for in an examination of more than 100 stomachs very little fruit was found, and that chiefly of wild varieties, while there was an entire absence of any remains indicating grapes.

### WARBLERS.

The family of warblers is of wide distribution and comprises species that are usually small and brilliantly colored. These differ greatly among themselves in habits, some remaining in the deepest shades of the forest, while others frequent groves, orchards, shrubbery, and gardens. Some seek their food by running over the bark of trees like woodpeckers or chickadees; others are terrestrial; but the great majority live on the insects which they find upon the leaves of trees. While definite data are wanting as to the food of these birds, field observation indicates that it consists largely of small caterpillars and other insects that feed on the leaves of fruit and forest trees. Although warblers are, individually, small, their numbers are great, and the quantity of insects they destroy in the aggregate must be large. A single observation will illustrate the character of their work. In the month of May, 1900, when the apple trees had just expanded rosettes of small leaves and flower buds, a multitude of warblers of several species were seen going through an orchard examining these rosettes, and apparently pecking something from each. An investigation of the trees not yet reached by the warblers showed that each rosette contained from one to a dozen large plant lice, while a similar investigation of the trees explored by the birds revealed few of these insects.

### VIREOS.

The vireos are similar to the warblers in habits. Several species commonly nest in the orchards and about the buildings, obtain their food from foliage, and so destroy many insects harmful to fruit trees.

### FOOD OF THE YOUNG BIRDS.

All these species do good service to the orchard when rearing their young. Our small birds, even those that, when adult, feed on fruit or seeds, rear their young on insects. Nestlings can not digest hard substances, such as beetles or hard seeds, so their parents select for them soft-bodied insects like caterpillars and other larvæ, young grasshoppers, and spiders. Stomach examination shows that they are fed on caterpillars or spiders almost exclusively during the first week of their existence, after which the diet is gradually changed and becomes more varied.

### BIRDS OF PREY.

When fruit trees are young, and more especially when they are in the nursery rows, they are subject in winter to attacks from various species of mice and rabbits, which gnaw the bark from the trunks, completely girdling the trees, and thus ruining them. As a case in point, may be mentioned a single small nursery a few acres in extent in Iowa, in which more than 3,000 trees had been girdled by rabbits in a single winter—one of several instances of equal damage that occurred in the same town. In a nursery of less than 5 acres, situated in Maryland, only a few miles from Washington, 2,000 out of about 4,000 apple trees were girdled and ruined by rabbits within two months. It is very significant that the nursery was near farm buildings where the wild enemies of the rabbits did not dare to come, while a newly set orchard at a distant part of the farm, and close by woods and thickets, was hardly touched.

Field mice and other small rodents are represented in the United States by numerous species, all of which may do mischief to young trees in winter, and most of which are doing some mischief at all seasons. Rabbits, as a rule, are not so numerous, but their larger size and fondness for young fruit trees makes their destructiveness fully as great as that of the smaller rodents, and, in fact, much greater in some sections where they are particularly abundant. But there is a group of birds which seems to be especially adapted to prey on these harmful rodents and hold their numbers within reasonable bounds; although it often happens that through the shortsightedness of man this wise arrangement is disturbed.

This group comprises the hawks and owls, of which about 73 important species and subspecies are found in the United States. Dr. A. K. Fisher has investigated[1] the diet of these birds, and has shown that the great bulk of their food consists of injurious rodents. After an examination of some 2,700 stomachs, only 6 of the 73 species and subspecies are classed as in the main harmful; the testimony of stomach examination is overwhelmingly in favor of the majority of the species. Mice, rats, rabbits, gophers, and ground squirrels constitute the chief food of most of the larger species, while many harmful insects are destroyed by the smaller ones. These birds at times feed on smaller insectivorous birds and poultry, but mice and other rodents are by far the commonest food of most species.

[1] Bulletin 3, Div. Ornith. and Mamm., Dept. Agr., 1893.

Hawks and owls hold the same relation to rabbits and mice that the smaller birds hold to the insect enemies of the orchard. For years they have been looked upon as harmful, but investigation has dissipated much of this error. While, as is the case with most birds, nearly all of them do some harm, the great majority are preeminently useful. Mice, rabbits, and other rodents are a constant menace to the interests of the fruit grower, and sometimes when through some combination of circumstances their numbers become superabundant, as has frequently happened in the case of field mice in Europe, their ravages are enormous. Indiscriminate slaughter of hawks and owls has often been followed by great ravages by voles and other mice. This should be sufficient to demonstrate the great utility of these birds as a check upon the undue increase of such pests.

GREAT HORNED OWL.—The great horned owl (*Bubo virginianus*), a bird well known in most parts of the country—though not often seen, owing to its retiring habits—is probably one of the most potent factors in holding in check that troublesome pest of the orchard and nursery, the common cottontail rabbit. Several years ago in a locality in eastern Massachusetts, through some unknown cause, rabbits became wonderfully abundant, and the following winter woodchoppers and others who visited the woods were surprised to see many great horned owls where in former years not more than two or three were annually observed. The presence of these birds so soon after the increase of the rabbits shows how quickly they avail themselves of an unusual supply of food, and thus restore the disturbed equilibrium. Unfortunately, it happened that at this time stuffed owls were fashionable as parlor ornaments, and taxidermists were therefore willing to pay a good price for them; so when it became known that the woods were full of owls, the natives did their best to reduce the number, and so perpetuated the rabbit scourge.

In a number of the Eastern States the rabbit is protected by law, and can be killed only during a small part of the year; but the animal is as much of a nuisance as are the various species of field mice, and the accident of its larger size only renders it capable of more mischief. To offer bounties for the destruction of hawks and owls and simultaneously protect rabbits is an anomaly of legislation which will probably puzzle and amuse future and wiser generations. The food value of the rabbit is insignificant compared with its capacity for mischief when it becomes overabundant. In the West the larger species, or jack rabbits, have many times become excessive in numbers, and "rabbit drives," in which the animals are surrounded and driven into a small inclosure, where they are killed, have grown to be of frequent occurrence. In Australia the European rabbit some years ago became so abundant as to threaten the very existence of the sheep industry over a wide expanse of territory. The common cottontail rabbit is already much too numerous for the best economic results in many States of the Mississippi Valley, and is likely to become so in the East if the protection of the law is not removed.

MARSH HAWK.—An idea of the good work done by hawks and owls in the destruction of smaller mammals may be obtained by watching a marsh hawk (*Circus hudsonius*) foraging for its dinner. This hawk preys extensively on the mice and other small mammals that live on the ground near fences and hedgerows. It may be seen skimming along close to the surface, following a fence up one side and down the other, stopping now and then to circle around a particularly promising spot, and examining every rubbish heap or stone pile, till a chance movement in the grass catches its eye, when, in an instant, it throws up its wings, suddenly checking its flight in mid-air, and drops with outstretched talons upon its unfortunate prey. Mouse after mouse will be taken in this way, each of which is capable of doing much mischief to trees or grain.

The extent of the benefit of this work and full corroboration of its character is shown by stomach examination. Thus, in the stomachs of 45 rough-legged hawks (*Archibuteo lagopus sancti-johannis*), taken in several different States, were found 128 harmful rodents, 1 weasel, 1 shrew, 1 lizard, and 70 insects. The rodents, besides 19 which could not be determined specifically from the remains, consisted of 1 gopher, 2 rabbits, 4 house mice, 4 white-footed mice, and 98 meadow mice. No traces of birds or poultry were found in any one of the 45 stomachs.

BARN OWL.—When hawks or owls devour their prey they usually bolt it whole or in large fragments, with the bones, hair, and many of the unremoved feathers. By the action of the stomach the indigestible portions, such as bones and hair, are soon separated from the flesh and rolled up in a neat pellet, which is then disgorged. In the vicinity of their nests many such pellets are to be found; and when these are dissected the bones, and still more the teeth, show what animals the bird has been eating. In a tower of the Smithsonian Institution in Washington a pair of barn owls (*Strix pratincola*) have had their nest for several years. Dr. Fisher visited this eyrie on several occasions, and collected 675 pellets, of which he made a careful study, with the result that he identified the remains of 1,787 small mammals, mostly rodents, 36 birds, and 2 frogs. Of the mammals, there were 1,119 common meadow mice, one of the worst enemies to young fruit trees as well as to farm crops in general.

### SHRIKES.

BUTCHER BIRD.—Besides hawks and owls, certain other native birds demand passing notice on account of the services they render by destroying mice. These are the shrikes, birds with many peculiar characteristics, whose food habits have been investigated by Dr. Sylvester D.

Judd.[1] One species, commonly known as the butcher bird (*Lanius borealis*), nests far to the north, but winters in the United States. It is a frequenter of orchards and open lands, where it constantly watches for its prey—mice, an occasional small bird, and what few insects it can obtain in winter. It is an inveterate enemy of the English sparrow, which it finds in parks and suburbs of cities and towns. A peculiar habit largely increases its usefulness. Its instinct for hunting is so keen that it can not refrain from taking its game whenever and wherever it can find it, and as the bird frequently is not hungry at the time of capture, it spits the prey on a convenient thorn, sharp twig, or barb of a wire fence. It was formerly supposed that the provisions thus saved were for future use; but although some may be subsequently eaten, most of them are left to dry up or decay.

LOGGERHEAD SHRIKE.—The loggerhead shrike (*Lanius ludovicianus*) is more southern in distribution. Its habits are similar to those of the butcher bird, but as it is with us during the summer, it captures more insects and fewer birds and mice. As it rears its young here, however, and so has occasion to use more food, it is probably fully as beneficial as the other species. Shrikes kill small birds, and to that extent do harm, but they seem to prefer mice when these can be obtained.

## BIRDS HARMFUL TO ORCHARDS.

The other side of the subject under consideration remains to be shown. The injurious habits of a few birds have already been mentioned. In the case of the shrikes, the destruction of small birds is likely to be detrimental, as small birds are generally valuable aids to the cultivator; but the injury done in this indirect way is more than counterbalanced by the destruction of mice and insects, which form the great bulk of the shrike's food. Sometimes the damage is more direct. A few birds feed in winter and spring on buds of trees, both in forest and orchard. Birds of this habit will be briefly considered.

### PURPLE FINCH AND HOUSE FINCH.

The so-called purple finch (*Carpodacus purpureus*) breeds in the northern tier of States and to the northward, west to the Dakotas, and south in the Allegheny Mountains as far as North Carolina, and winters from the southern part of its breeding range south to the Gulf States. When migrating in spring it subsists somewhat on buds of fruit and other trees, and later occasionally destroys the blossoms. The actual damage done by the Eastern purple finch seems trifling, but in the case of its Western relative, the house finch, or linnet (*C. mexicanus frontalis*), the matter is much more serious. This closely related bird does much harm, especially in California, by destroying the flower buds of peach, apricot, almond, and other trees. In many cases serious

[1] Bulletin 9, Biol. Surv., Dept. Agr., 1898.

injury has been done in this way, and much expense entailed, as the birds are wonderfully abundant in that section of the country.

ROBIN.

The robin (*Merula migratoria*) has often brought itself into unenviable notoriety by its depredations upon small fruits. Many complaints have been received from growers of fruit, especially those who raise but a small amount. Sometimes people who grow a few choice cherries do not get even a sample of the fruit, and those who raise fine strawberries for family use sometimes secure only a few boxes, while the robins take most of the crop. On the other hand, thousands of fruit raisers in various parts of the country are never troubled by robins, although these birds may be just as abundant in their vicinity as elsewhere. The probable explanation of this is not far to seek. An examination of the stomachs of 500 robins, collected in various parts of the country, shows that cultivated fruit forms but a moderate percentage (less than 8 per cent) of their diet; and that practically all of this is eaten in June and July; while wild fruits, of which 42 varieties have been identified, constitute more than 43 per cent of the year's food. Investigation shows that complaints have come chiefly from two principal sources, the suburbs of large towns in the East and the prairie region of the West. Such localities lack those wild fruits which robins evidently prefer. Near cities such fruits have been destroyed, and in the prairie region they rarely grow. As soon as the prairies were settled many small fruits were planted, thus affording a supply of food to the birds, while the larger fruit trees furnished sites for their nests. As none or but few of the wild fruits were accessible, it follows naturally that the birds resorted to the available supply, that is, to the cultivated varieties. Much the same condition has been created about large cities by the substitution of cultivated for wild fruit.

CATBIRD.

In parts of the Mississippi Valley the catbird (*Galeoscoptes carolinensis*) also has become one of the pests of the small-fruit orchard. East of the Appalachian range there are so many varieties of wild fruits in forests and swamps that, as a rule, the bird confines itself to these localities and does not disturb orchard products. In the prairie region, however, it is different. Before that part of the country was settled the bird was confined to the narrow belts of woods and shrubs along streams, where it found agreeable nesting sites and suitable food. When civilization transformed the prairies into farms, gardens, orchards, and vineyards, a new field was opened to the catbird as well as to other species. The fruit trees and vines not only furnished secure nesting places, but also afforded a new and abundant source of food. It is probable that this resulted in a decided increase in the numbers of the birds, which, depending largely on domestic fruit for their food, soon became a nuisance. These conclusions, as has been suggested in several recent considerations of this subject, point to the planting of wild fruit about gardens and lawns as a protection to the cultivated varieties. Many of the wild fruit shrubs are ornamental, either in flower, as the shadbush (*Amelanchier*), or in fruit, as the mountain ash (*Sorbus*).

### CEDAR WAXWING.

The cherry bird or cedar waxwing (*Ampelis cedrorum*) occurs over the greater part of the United States and is known everywhere by its fondness for cherries and other small fruits. Like the robin and catbird, however, it eats far more wild than cultivated fruit. Complaints against it have been chiefly on account of cherry eating, but its depredations are mostly confined to the early ripening varieties of cherries. By the time the later kinds ripen other fruits have also become abundant, and the bird's attention is probably diverted.

Besides eating fruit, the robin, catbird, and waxwing destroy many harmful insects, and, where not too numerous, probably do much more good than harm. All three species are very abundant in New England, but are seldom molested. The cherry bird is the only one of which serious complaint is made, and that simply on the score of stealing early cherries, while the robin is regarded almost as sacred.

### CAUSE OF HARM BY BIRDS.

A careful examination of the circumstances in which birds have done harm leads to the belief that the damage is usually caused by an abnormal abundance of a species within a limited territory. In such cases so great is the demand for food that the natural supply is exhausted and the birds attack some of the products of garden or orchard.

Economically considered, birds are simply natural forces, and it should be our purpose to ascertain how they may be turned to our greatest advantage. The best economic conditions are probably fulfilled when birds are numerous as species and moderately abundant as individuals. Under such conditions there will be a demand for food of many kinds, without excessive demand for any one kind. The most desirable status would seem to be such a relation of numbers and species between birds and insects that the birds would find plenty of food without preying on useful products, while the insects would be held in such check that they would neither increase to a harmful extent nor be completely exterminated. The proper course to pursue, apparently, is to study the food habits of both birds and insects, to favor the increase of species which seem best adapted to preserve the proper balance, and to reduce the numbers of those that prey too greatly on the products of orchard or farm.

# SOME POISONOUS PLANTS OF THE NORTHERN STOCK RANGES.

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## INTRODUCTION.

The territory regarded in this paper as belonging to the northern stock ranges includes the greater portion of the seven States extending from the Dakotas and Wyoming westward to the Pacific. With the exception of the highest mountains, the more densely forested coast area, and occasional stretches of unusually arid or alkaline land, it is all rich in nutritious grasses and forage plants, and has long borne an excellent reputation as a hunting and grazing country. Just as in the earlier part of the nineteenth century hunters and traders repaired thither with their outfits and gained good livelihoods by killing buffalo, bear, elk, deer, and other animals for their flesh, hides, and fur, so now, within the last two or three decades, many persons have gone there to take advantage of the free pasturage and to seek their fortunes in producing flesh, hides, and wool from the immense numbers of stock which the country is so abundantly able to support. One drawback to the industry consists in the presence of several poisonous plants, which are sometimes extensively eaten by different kinds of stock, occasioning serious losses. An investigation has been undertaken with the purpose of finding out how to reduce this evil, and this paper presents a part of the results. The plants considered here include only those native species which are the best known, and which have most frequently been reported as having caused serious cases of acute poisoning in stock throughout the whole of the territory.

The rapidly growing importance of the stock industry in the territory described above is most emphatically shown in the case of the sheep industry in Montana. In January, 1900, this State ranked first in wealth of sheep and second in the number of sheep which it possessed.[1] At as recent a date as 1870, however, there were but 4,212 sheep in the State. The number has increased with remarkable steadiness. In 1880 there were 249,978; in 1890 the number had increased to over 1,500,000, and now it has about 4,000,000.[2] The rate of growth has not been so adequately worked out for the whole region, but an

[1] Yearbook of the Department of Agriculture for 1899, p. 821.

[2] Third Annual Report of Board of Sheep Commissioners of Montana for 1899.

examination of the statistics for January, 1900, shows that it held approximately 31.9 per cent of the total number of sheep in the United States and 32.5 per cent of the total value of $122,665,913.[1] When it is considered that in 1880 the approximate percentage to total of all sheep held on stock ranges in the United States was but 16 per cent,[2] the rapidity of growth will become evident. The growth of the other stock industries has been rapid also; but since, as will be shown, sheep are more frequently poisoned by plants than other stock, it will not be necessary to consider the latter in detail. The whole area is now very heavily stocked, but it can not be said to be overstocked. It is certain that alfalfa, red clover, or alsike can be as successfully raised under irrigation in many places throughout the range area as they have been in Montana, and consequently a much larger number of stock can be raised there and carried in good condition over winter. Thus, greater profits would be realized and a healthier stimulus given to the improvement of breeds. The loss from poisoning by plants would be materially reduced by feeding the animals instead of allowing them to graze in early spring, when poisonous plants cause the greatest damage.

## GENERAL CONDITIONS LEADING TO THE KILLING OF STOCK BY PLANTS.

About a third of the stock produced in the United States is raised in comparatively small flocks on farms in agricultural regions where, with plenty of leisure, the animals can get an abundance of pure food and fresh water, and where, especially in winter, they can be well fed and sheltered. The full domestication which is thus brought about very naturally reduces the mortality due to the poisonous flowering plants to a minimum. Even in the well-tilled State of Indiana, however, where there are no extensive public ranges, the loss of stock from plant poisoning has been estimated to be several thousand dollars a year. But much of the loss in this and other agricultural regions is due to the eating of corn or other staple fodders which are poisonous by having become moldy in consequence of improper handling, or which have been contaminated, in course of trade, with poisonous weed seeds, such as cockle (*Agrostemma githago*), or blighted by fungous diseases, such as ergot and oat smut. Some of these agents show their effects only after long-continued use, when they finally produce symptoms of chronic poisoning which so closely simulate disease that the real cause may frequently be overlooked. Cockle and also the spring cockle (*Vaccaria vaccaria*) are widely disseminated in various parts of the Northwest, and their seeds are not infrequently found in wheat and other grain. The use of improved machinery has enabled the miller to eliminate the seeds from grain used for human

[1] Yearbook of the Department of Agriculture for 1899, p. 821.
[2] Scribner's Statistical Atlas (1883).

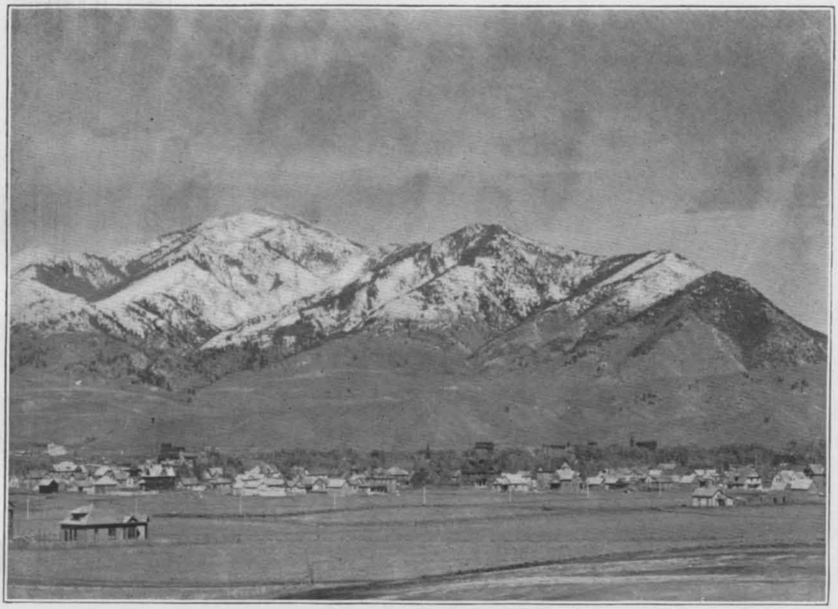

FIG. 1.—A MOUNTAIN STOCK RANGE (BRIDGER PEAK, MONTANA; MAY, 1900; ALTITUDE, 9,106 FEET). DEATH CAMAS AND PURPLE LARKSPUR ABUNDANT JUST BELOW THE SNOW LINE.

FIG. 2.—CLOSELY-CROPPED RANGE, WITH TEMPORARY SHEEP CAMP AND THE SKINS OF SHEEP WHICH HAVE BEEN POISONED.

food, but the screenings therefrom, especially those containing cockle, are often fed to stock in considerable quantity. These seeds contain a poisonous sapotoxine-like substance, and are regarded in Europe as the cause of the chronic poisoning or disease of man and animals which is known as *githagism*. To what extent stock are thus affected in the United States is unknown. Some farmers regard cockle seeds as good food.

The cornstalk disease, which extends northward into a few localities in the northern stock ranges, especially in South Dakota, is a strange, little-understood malady of cattle, due to the eating of dry cornstalks in the field after harvest. As corn of itself is not poisonous, the real cause of the malady has been variously attributed to bacteria, to parasitic fungi, and to saltpeter, which may, under different conditions, be present on the corn, or simply to malnutrition or impaction of the alimentary canal. In one instance of poisoning by corn, reported by Prof. D. A. Saunders,[1] a peculiar bug, known as Uhler's green plant bug, seems to have been the cause. This bug, which passes the winter under clods and in the rolled-up leaves of cornstalks, some of which were eaten with fatal results by several cows, was found in very large quantity (over a quart) in the stomach of one of the dead cows.

The fatal effects of green sorghum, a plant somewhat closely related to corn, which is cultivated to a limited extent in the Northern stock ranges, must be due to an entirely different cause, but this is likewise very little understood. It may be brought about, as explained by Wyatt Thompson,[2] in a purely mechanical way by the leaf, on account of its sticking to the walls of the throat and covering the glottis so as to cause suffocation. Similar fatal results attend the use in China of gold foil, which is occasionally taken by wealthy Chinamen for the purpose of suicide.[3] Another interesting theory which has recently been advanced is that it is only the blossoms of sorghum that are poisonous, as is the case with Guinea corn in the Barbados Islands, north of South America.

The general conditions on the great stock ranges are very different from those existing in farming regions. Although the pasture areas are often of very superior merit and are far more extensive than in the farming regions (Pl. XXXII), the stock have not invariably a sufficient amount of food. Nature is expected to supply both forage and fodder to the semidomesticated animals. New sheep, which are totally unfamiliar with the wild plants on the ranges, are constantly being brought in from farms, and these animals are expected at once to seek out a proper subsistence. The drinking water is usually more or less alkaline, and, especially when the alkaline salts contained in it are

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[1] South Dakota Experiment Station Bulletin No. 57, p. 45, 1898.

[2] The Southern Farmer, Vol. X, No. 6, pp. 2, 3, August 11, 1900.

[3] Matignon (J. J.), Arch. d'Anthrop. Crim., Vol. XII, pp. 365–417, 1897.

permitted to serve as a substitute for common salt, the tendency undoubtedly is to foster an unnatural appetite in the stock. Weather conditions, especially untimely snow falls, not only cause great fatality by freezing, but also render the food supply very uncertain, and last, but not least, the danger of loss from straying away and from coyotes and wolves renders it sometimes advisable to herd the sheep too closely together to permit them to graze with leisure. The danger from moldy food is naturally reduced to a minimum. The diseases resulting from plant poisoning known as *locoism* and *crotalism*, which prevail in some parts of the West and Northwest, are caused, respectively, by the continued eating in the field of some one of the several locoweeds (*Astragalus* and *Aragallus* species) and by the eating of the rattleweed or rattlebox (*Crotalaria sagittalis*) either in the field or in hay.

The evil effects of the almost exclusive feeding of millet hay (*Chætochloa italica*) in North Dakota has been pointed out by Prof. E. F. Ladd,[1] but the chemical substance which he isolated is hardly sufficiently active to render the hay poisonous.

From these general considerations it is evident that a larger number of the more purely accidental cases of stock poisoning should be expected on the ranges than on farms in the nonrange States. As a matter of fact, the vast majority of fatal cases reported to the Division of Botany of the Department have occurred on ranges, and most largely on those of the Northwest. Most of the American literature on the subject has likewise emanated from these same regions, the agricultural experiment stations of Oregon, Washington, Montana, North Dakota, and South Dakota having each issued one or more bulletins on the subject.

## SPECIAL RANGE CONDITIONS.

The chief circumstance leading to death from poisonous plants on the great ranges is, as has already been seen, the irregularity of the food supply, as determined by the more or less unusual conditions under which stock is sometimes placed in these regions. It can hardly be presumed that the buffaloes and other ruminants which formerly ranged over these areas in countless numbers were very frequently, if ever, killed by eating poisonous plants, for, in the first place, being bred there under perfectly natural conditions, and being abundantly able to roam over long distances in search of food and water, they naturally rejected all but the best and most wholesome diet. Then in the winter they migrated to the south, where the conditions for their existence were more favorable. They grazed in immense herds, but spread themselves out over a large area and ate with leisure. Besides, it

[1] North Dakota Experiment Station Bulletin No. 35, pp. 323–325, 1899.

would require a large quantity of any of the common poisonous plants to kill an animal of such size. Cows, and especially horses, will likewise endure a comparatively large quantity of the commoner deleterious plants, and they, especially the horses, are likewise able to travel over long distances to secure food. It is little wonder, therefore, that but few of these animals are poisoned while out at pasture, even though they are sometimes left to take care of themselves throughout the entire winter. They are poisoned chiefly by being forced to eat certain plants when the shorter herbage is covered with snow, by pulling up and eating the poisonous roots of another class of plants when the ground has been softened by long-continued rain, or by eating hay cut from native meadows which is either partly poisonous of itself, as is lupine hay under certain conditions, or has an admixture of poisonous plants, such as water hemlock (*Cicuta* species).

Sheep are often poisoned by comparatively small quantities of certain poisonous plants, and although (unlike cattle and horses) they are herded constantly when on the range, at times their supply of food is extremely precarious. Most stockmen have their summer and winter pastures. Especially fine areas are also reserved for use during the lambing season. It sometimes happens that these particular pastures, being Government property, have been already grazed clean by bands belonging to unfriendly rivals. When herders are thus forced to select other pastures it is generally impossible to find such good ones, and often no good pasturage is immediately available. In one such instance observed by the writer in Montana in May, 1900, over a hundred ewes and lambs perished from eating some poisonous plant.

When the summer pasture is far distant from that used in winter, and the intervening country is comparatively barren, the sheep often become so hungry that they will graze ravenously and indiscriminately. A third source of danger lies in the method of herding sheep which is in vogue on the ranges. An individual band often contains as many as 2,500 sheep. It is essential, in order to guard against the attacks of wolves and coyotes and against loss by straying away over the unfenced range, that the sheep be prevented from separating too widely. They are therefore kept in more or less compact bands, shepherd dogs being trained to assist the herder in this work. When such a band of sheep is driven more rapidly than usual, the sheep which are in the center, or near the end, have but little chance to select their food, and become so ravenous that they are careless as to what they eat. Still further, it must be remembered that if the sheep are unaccustomed to the range they are far more apt to eat the injurious plants which sheep native to the range would avoid. Considerable loss is occasionally caused by turning sheep out of freight cars while on their way to distant markets and allowing them to graze on whatever herbage may happen to be found at the various stopping places.

## WATER HEMLOCKS.

GENERAL CHARACTERS.—The local species of water hemlock are the plants best known throughout the whole of the Northern stock regions as poisonous to stock. These are members of the genus Cicuta, belonging to the carrot family. There are at least three distinct species of this genus in the Northwest, the fleshy roots of which, under the erroneous name of "wild parsnip," are rapidly fatal to man or beast if eaten even in small quantity.

FIG. 39.—Purple-stemmed water hemlock (*Cicuta douglasii*).

All are alike in being smooth, generally erect, perennial herbs, 3 to 8 feet high, with one or more upright hollow stems, numerous branches, mostly bipinnate leaves with lance-like and serrate-edged leaflets 1½ to 4 inches long, and terminal umbels of small white or greenish-white flowers. The seeds, and especially the fleshy roots, together with the geographic distribution of the plants, serve to distinguish the species. Pl. XXXIII and fig. 39 afford an excellent idea of the general features of the group, and fig. 39 may well serve to indicate, in a general way, the character of the upper part of each species.

SPECIES AND THEIR DISTRIBUTION.—The most widely known member of the group in the United States, the American water hemlock (*Cicuta maculata*), is probably the most deadly plant native to this country. An account of its poisonous character may be found in the Yearbook of the Department for 1896, pp. 142–144. A very similar species (*C. virosa*), which is equally poisonous, is well known throughout Europe. Both of the latter species, although fatal if eaten by animals, are best known as being dangerous to man. Children especially are killed by eating the fleshy rootstocks in the early spring, when they are most apt to be exposed by being washed or frozen out of the soil. The American water hemlock is abundant in the more humid eastern part of the United States, but apparently it does not extend very far into the drier portions of it which are considered in this paper.

FIG. 1.—OREGON WATER HEMLOCK (CICUTA VAGANS).
[One-half natural size.]

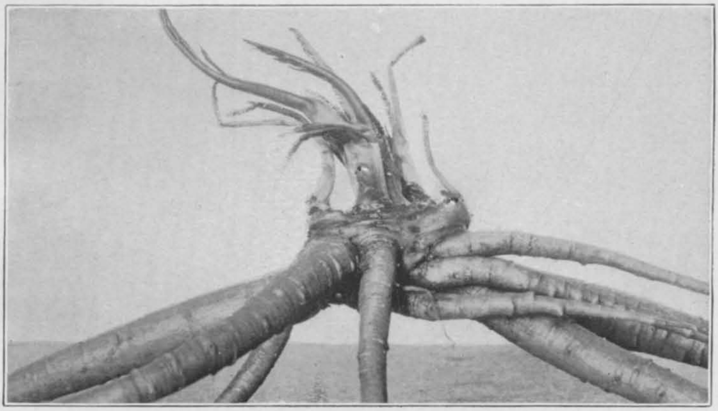


FIG. 2.—WYOMING WATER HEMLOCK (CICUTA OCCIDENTALIS).
[One-half natural size.]

Several Western species are best known as stock-poisoning plants. In Wyoming, and probably throughout all the adjoining States, the Eastern plant is very largely, if not entirely, replaced by the Wyoming water hemlock (*C. occidentalis*), a not very different plant. The purple-stemmed water hemlock (*C. douglasii*), as well as the Oregon species (*C. vagans*), is native in springy and boggy places and along streams on the humid Western coast. It is not so widely distributed as *C. vagans*, but is well known as a poisonous plant in Washington and in British Columbia. Fig. 39, showing the species, is reproduced from a photograph taken, and kindly placed at the disposal of the Department, by Hon. J. R. Anderson, deputy minister of agriculture of British Columbia, who has also supplied many roots for examination. The Oregon water hemlock is widely distributed from northern California and Nevada to Washington and Idaho, but is most abundant in Oregon. Pl. XXXIII, fig. 1, shows the characteristic shape and position of the rootstock and roots of the Oregon species, and Pl. XXXIII, fig. 2, shows the general form of the roots of both the purple and the Wyoming species. The latter have no rootstock like that shown in Pl. XXXIII, fig. 2. The purple-stemmed species differs from the Wyoming plant in having a purple instead of a green stem, smaller and more numerous roots, and various minor characters, which are of interest from a scientific point of view only. The Eastern species has short, spindle-shaped or oblong tuber-like roots, which are about an inch or two in length. All grow in damp ground, either along creeks and ditches, or in low marshy places, especially along the banks of coast rivers almost down to the salt water, and frequently in meadows which are cut for hay.

Odor.—Like most of the members of the carrot family, to which the water hemlocks belong, they have a peculiar penetrating odor and taste, due to the aromatic oily fluid which is found throughout the plants, especially in the roots and seeds. It is probably on account of this odor that the plants are usually compared with the parsnip, which is the only commonly known fleshy-rooted member of the carrot family possessing a similar odor. In the case of the water hemlocks, however, the odor is more decidedly musky and much more disagreeable. The parsnip has one large fleshy taproot, and never becomes poisonous when growing without cultivation. The water hemlocks have a cluster of fleshy roots, which are highly poisonous, the oily fluid in them containing a highly virulent substance, which is probably the same in all the species.

Roots.—The roots are said to have a benumbing effect upon the tongue after long chewing. Unfortunately, however, the first taste is somewhat sweet and not sufficiently disagreeable to deter children and even men who are in search of wild aromatic roots from quickly eating a sufficient quantity to produce fatal results. They are generally eaten by mistake for other wild-growing roots of the carrot family which have a somewhat similar taste. Cases of human poisoning have been recorded against all of the species of the Northwest with the exception of the purple-stemmed one. In the spring of 1900 as many as four people were killed in Montana by eating the roots of the Wyoming species. The poisonous properties of all of the species are well known to the Indians, who occasionally use them for suicidal purposes. One such case, which recently occurred in Nevada and was investigated by the Department, was due to the Oregon species.

In the case of each of these plants the root is the part best known to be fatal to stock, but the tops are also poisonous under some conditions. After long-continued rain the roots are so loosened that they can be pulled out of the ground without difficulty by stock while grazing. In some cases the oil has been swallowed with water found in marshy places where the roots have been trampled upon. Horses that are used for plowing virgin soil in wet land are not infrequently killed by eating the exposed roots. Poisoning from the roots takes place during winter and early spring, and observations seem to indicate that the roots are poisonous only at that time of the year. A piece of the Oregon root about the size of a walnut is, according to Professor Hedrick,[1] sufficient to kill a cow. Animals may be killed in the pasture by eating the young leaves or stalks of plants less than a foot or two high. The basal portions of such plants are, at least in the case of the Wyoming species, much more poisonous than the tops.

LEAVES, SEEDS, AND STEM.—The green leaves from the taller plants are not nearly so dangerous as the lower portions. Seeds on plants cut with wild meadow hay, and perhaps to a lesser extent the leaves and stems of such plants, have caused a very considerable loss of stock in the Dakotas and Montana. Such hay is very much more apt to be fatal if fed in boxes, for the seeds, which are easily detachable, are not then lost when the plants are tossed about by the animals in eating, but accumulate in the bottom of the box, and are, therefore, more apt to be eaten.

DAMAGE CAUSED.—No systematic attempt has ever been made to obtain statistics showing the extent of the damage caused by the water hemlock in the Northwest. That it is considerable may be judged from the fact that so much attention has been paid to the plants by various experiment stations. One man on the Sprague River, in Oregon, has recently spent much time and money in an attempt to eradicate the plants from his range, and Professor Hedrick has stated that an estimated death rate of one hundred cattle per annum was low for that State. During an investigation of the poisonous plants of

[1] Oregon Agricultural Experiment Station Bulletin No. 46, 1897.

Montana in the months of May and June, 1900, Dr. E. V. Wilcox and the writer noted thirty-six cases of water-hemlock poisoning among cattle, thirty of which were fatal, and one hundred and five cases among sheep, fifty of which were fatal. It will thus be seen that the death rate was very high. The above deaths represent a loss of over $4,000, but this is only a fraction of the entire loss in Oregon and Montana for that year.

SYMPTOMS OF POISONING.—The symptoms of poisoning resulting from the accidental eating of any of the poisonous parts of any of the water hemlocks agree well with each other, and also with those obtained in experimental ways. The effect of the Oregon plant has been noted by Profs. H. T. French and U. P. Hedrick[1] in the case of a yearling calf that ate two of the roots one morning at about 9.15 o'clock. At 10.25 o'clock the muscles of the flanks began to twitch, the eyes watered, and the animal became excitable. Its temperature had risen to 104°. There was also a marked increase in the amount of urine voided, a symptom which was prominent until death. The first spasm took place at 10.45. There was then a marked activity of the sweat glands, and the rate of breathing was doubled. At 11.30 o'clock the calf had another spasm, and this was followed by others in rapid succession until death ensued at 11.45. Other observers have noted other symptoms, the most prominent of which are an increased flow of saliva, bloating, severe pain in the stomach, and widely dilated pupils. Death takes place within a few, sometimes within one and a half, hours after the plant has been eaten.

EFFECT OF THE POISON AS SHOWN BY POST-MORTEM.—Post-mortem examination nearly always reveals the characteristic musky odor and often pieces of the plant, especially the root, in the stomach. These furnish the most conclusive evidence of the nature of the poison, for there seem to be no very characteristic lesions. The lungs and brain are often highly congested, and one authority, Prof. L. H. Pammel,[2] cites a correspondent who states that in the case of a cow killed by eating some roots the mucous membrane of the stomach was black and as easily scraped off with a stick as if it had been scalded.

NATURE OF THE POISON.—The American water hemlocks have not been carefully analyzed, but probably all of them contain the peculiar compound known as *cicutoxin*, which was first isolated by R. Boehm[3] from the European plant. Two-tenths of 1 per cent of the pure substance was obtained from the fresh root and 1½ per cent from roots which had been dried. As described by Boehm, it is an uncrystallizable, resinous body with an acid reaction and a disagreeably bitter

[1] Oregon Agricultural Experiment Station Bulletin No. 46, 1897.
[2] Iowa Agricultural Experiment Station Bulletin No. 28, article 5, 1895.
[3] Arch. f. exper. path. u. Pharmakol, Vol. V, pp. 279–310, 1876.

taste. It is very soluble in boiling water and in dilute alcohol. This substance is not an alkaloid nor a member of any extensive class of poisons, but belongs to a small group of very poisonous compounds known as toxins. Andromedotoxin is a similar substance, which is found in many well-known plants belonging to the heath family (*Ericaceæ*), some of the members of which, such as sheep laurel (*Kalmia angustifolia*) and calf kill (*Leucothöe catesbaei*), are well known along the Atlantic coast as poisonous to young stock. The fatal dose of cicutoxin for cats is 50 milligrams for each kilogram of body weight when administered through the mouth and 7 milligrams per kilogram when injected hypodermically. One hundred milligrams (about 1.4 grains) will kill a cat weighing about 2 kilograms (4.4 pounds) if fed to it. The prominent symptoms are very similar to those produced when the plant itself has been eaten, and consist of salivation and constant trembling of the limbs, with cramps and convulsions, finally ending in death.

Remedies sometimes used.—Cases of the poisoning of stock by the water hemlocks are very difficult to handle, both because the animals generally become wild and unmanageable and because the action of the poison is so rapid that the animal is usually dead when found. Tannin is mentioned by Fröhner[1] as a chemical antidote, but it must be used together with chloral or with hypodermic injections of morphine to offset the physiological action of the poison already absorbed into the system. Animals generally die after eating fatal doses, but they are able in some instances to vomit the excess and recover. Stockmen occasionally save their animals by administering two or three daily doses of melted lard.

Necessity of eradicating the plant.—There being no effective rational antidote for use in water-hemlock poisoning, stockmen should become thoroughly acquainted with the plants in all of the stages of their growth, in order that they may take the proper steps to eradicate them from their ranges or prevent their animals from eating them. Repeated plowing will kill the plants and repeated mowing may do so. Whenever practicable the roots should be grubbed up, preferably in spring, and piled together in some out-of-the-way place or burned. Meadows rich in water hemlock should not be used for hay unless previously freed from the plants by hand pulling or by removing the seeds. Hay containing small amounts of the seed might be fed from the ground, but not in boxes. Regular drinking places, and especially inclosed pastures, should be kept scrupulously free from the plant.

## LARKSPURS.

Species.—The various species of Northwestern larkspurs have not, so far as known, caused any cases of human poisoning, but stockmen

[1] Lehrbuch der Toxicologie für Thierärzte, Stuttgart, 1890.

throughout the entire western half of the United States are fairly well agreed that, in certain stages of growth at least, the different species are poisonous to animals. They have proved nearly as fatal to stock as the water hemlocks and probably kill a larger number than any other class of plants.

At least six species in the Northwest have been suspected as poisonous. These may be divided very conveniently for our purposes into two classes, the low and the tall, of three members each, the former being less than 1½ feet high, and the latter varying from 2 to 5 feet. The low species include the common purple larkspur of Montana (*Delphinium bicolor*, fig. 40), here presented as a type, with thick deeply parted leaves and semifleshy roots; the coast species (*D. menziesii*), with coarse granular roots and wing-margined seeds, and the blue Wyoming larkspur (*D. geyeri*), which is distinguished from the two preceding by its denser tuft of root leaves, and in having from three to five instead of only three similar parts to its fruits. All of the foregoing are very much alike, but even the casual observer distinguishes them from the tall forms. The latter include the common tall larkspur (*D. glaucum*, fig. 41) of the Pacific slope region, which is characterized by its broadly orbicular leaves and nonpubescent fruit, and by being mostly covered with a white coating or bloom, like that observed on ripe plums; the Rocky Mountain larkspur (*D. scopulorum*), which has pubescent fruit, but is otherwise so strikingly like the preceding that it is commonly mistaken for it by botanists; and, finally, the Columbia River species, which is characterized by having comparatively few large flowers in its long raceme, the flowers being smaller and much more crowded in the other two species.

FIG. 40.—Purple larkspur (*Delphinium bicolor*).

Figs. 40 and 41 present a good idea of the two groups. They are all more or less simple-stemmed perennials with succulent, long-stemmed root leaves, simple racemes of irregularly shaped flowers, bearing a more or less conspicuous spur, and a dry compound seed capsule. The tall species generally grow in damp soil or in woods; the lower occur most abundantly in rather dry grassy meadows near the mountains. All send forth their first leaves very early in spring, and, other vegetation being less developed, they are then most tempting to cattle.

The earlier leaves of the tall larkspur closely resemble those of the wild geranium (*Geranium viscosissimum*) of those regions, which is a good forage plant. It may easily be distinguished from the larkspur, however, by its dense pubescence, and after blossoming by its regular wheel-shaped flowers. The earlier leaves of the red false mallow (*Malvastrum coccineum*) are much like the earlier leaves of the two easternmost low larkspurs, but are easily distinguished by being densely covered with clusters of star-shaped hairs.

FIG. 41.—Tall larkspur (*Delphinium glaucum*).

HOW STOCK ARE POISONED.—Stock new to the region may possibly mistake the larkspurs for the above-named plants, but it is doubtful if they do so. They are probably poisoned either by greedily eating the leaves when first allowed to graze in the spring, or when first imported to the range, or by being constrained to eat them on account of snow covering the other herbage. In the fall, also, cattle are sometimes poisoned by eating the seeds when other herbage is covered with snow. Sheep are more frequently killed by the low, and cattle by the tall, species.

POISONOUS QUALITY OF LARKSPURS.—Considerable discussion has arisen regarding the poisonous quality of the larkspurs, on account of the fact that the leaves from the flowering plants of one or more of the above species are sometimes voluntarily eaten by stock or have been fed to them without any ill consequences. As a rule, the leaves of most plants contain the largest percentage of their toxic principles at flowering time, but this is not always the case, as has recently been shown for two of the species of larkspur. In the two species here shown (figs. 40 and 41) the young leaves are far more bitter and toxic before flowering time, and it is during this period that all of the species cause the largest percentage of deaths. Stock are, of course, more apt to eat the plants in early spring, because they are then more succulent, as may be seen in the case of the purple larkspur, by comparing the right-hand plant with the left in fig. 40. The former shows but one partially developed capsule, while the latter shows several which are in an advanced stage of development. Experiments and observations made in Montana by Dr. Wilcox and the writer plainly show that the leaves from the flowering plants are much less toxic than those from plants which have not yet blossomed. It is highly improbable that the roots of the tall species are ever eaten, because they are so woody, but the roots of the low forms may be pulled up and eaten, especially after long-continued rain. Our experiments with roots of the purple larkspur indicated that the younger roots are likewise more toxic.

Species causing losses.—Various larkspurs kill a large number of stock in Idaho and Washington; the Rocky Mountain larkspur is reported by Prof. John Macoun[1] as having caused some damage to the stock industry in Canada; the various Oregon species are considered to be about equally responsible with the death camas for the majority of the cases of poisoning by plants which occur in that State; the Wyoming larkspur is probably the most destructive plant of Wyoming; and in Montana the purple and the glaucous species are responsible[2] for a very large amount of sheep and cattle poisoning. During the gold excitement of 1898 in Alaska many pack animals and beef cattle were reported to have been killed by eating the tall glaucous species which grows plentifully along the Dalton and Teslin trails. No estimate has been made of the annual loss caused by the various species.

Symptoms of poisoning.—The symptoms of poisoning have been carefully determined for but a few of the species. For these they agree well with each other, and, judging from the reports of stockmen, the symptoms are similar for all of the various species. As observed by Dr. Wilcox, in many cases of sheep poisoning by the purple larkspur of Montana, these symptoms were very similar to those produced by aconite, and consisted in a stiff straddling gait, especially in the hind legs, involuntary twitchings of the muscles of the legs and sides, and incoordinated movements. In the earlier stage there was a decrease in the rates of the pulse and of the breathing, but these gradually increased and finally became extremely rapid but feeble. The involuntary movements became more and more frequent

[1] Canadian Department of Agriculture Bulletin 1, Northwest Territories, 1898.

[2] Dr. E. V. Wilcox in Montana Agricultural Experiment Station Bulletins Nos. 15 and 22, 1897, 1899.

and severe until the sheep rolled over and died in violent spasms. The appetite remained good until near the time of death; there was no increased flow of saliva and no mental disturbance. The animals were, however, very easily frightened, and one was killed apparently by the extra excitement caused by being rolled over on the ground.

EFFECT OF THE POISON AS SHOWN BY POST-MORTEM.—Post-mortem examinations showed that the brain, intestinal tract, liver, and most of the internal organs were normal. The right side of the heart was full of blood while the left was empty. The lungs were heavily congested with dark, deoxidized blood, which showed clearly that it had not been sufficiently purified through respiration. The leaves, stems, and roots of the plants were found in the stomachs of some of the sheep.

REMEDIES.—When a sheep is observed in the early stages of poisoning, as is usually the case in bands which are being herded, the feeding of a chemical antidote consisting of a 1 per cent solution of potassium permanganate, together with a 1 per cent addition of aluminum sulphate, may save it, as has recently been shown by experiments made in Montana by Dr. Wilcox and the writer. Dr. Wilcox has shown that atropine is an excellent antidote to counteract the effects of the poison already absorbed into the system. The permanganate mixture should be kept in a finely powdered condition and dissolved in pure clean water when needed. One-third of an ounce of each salt is the proper quantity to dissolve in a quart of water. This will be a sufficient amount for dosing from 20 to 30 sheep, 7 to 10 horses, or 3 to 5 cows, all being considered as adults. These amounts should be reduced according to the usual rule, especially for very young animals. This antidote may be given in all stages of the poisoning, for it is comparatively harmless to the animals, and it oxidizes or destroys most, if not all, of the poison that remains in the stomach. Atropine should be given hypodermically to offset the more severe symptoms due to the poison already absorbed from the stomach. The dose of this alkaloid in the early stages is about one-half a grain for adult horses or cattle, and one-tenth of a grain for adult sheep. In the later stages, when the symptoms are severe, it should be increased to 1 grain for horses or cattle, and one-third of a grain for sheep.

WHEN THE PLANTS ARE MOST POISONOUS.—To prevent stock from eating the larkspurs, stockmen should make themselves thoroughly familiar with the plants, especially in the early stages of growth, in order that they may herd the animals away from the worst patches in the early spring, when all of the plants are probably most poisonous, and when animals are most apt to eat them. After the flowers have appeared there is little danger to be feared from the plants. Limited areas might easily be cleared from the tall larkspur by grubbing out the roots or cutting the plants down in the spring when their growth is most vigorous.

## POISON CAMAS.

Species and distribution.—The two preceding groups of plants have one or more different representatives in nearly all parts of the north temperate zone, some of which are very widely distributed. The species of poison camas (*Zygadenus* species) are but few in number and in great part confined to the northwestern and western parts of North America. One species occurs in Siberia and another in Mexico. Their published reputation as poisonous plants is, however, mainly confined to America and to the last century. They are all poisonous, and sometimes fatal to both man and beast. They are all smooth, single-stemmed, onion-like, but unscented plants, one-half to 3 feet high, with coated bulbs, long, grass-like leaves, and single cylindrical clusters of yellow, white, or greenish flowers, which finally develop into dry, three-horned seed capsules. The plants have much the appearance of grass in the early stages of their growth.

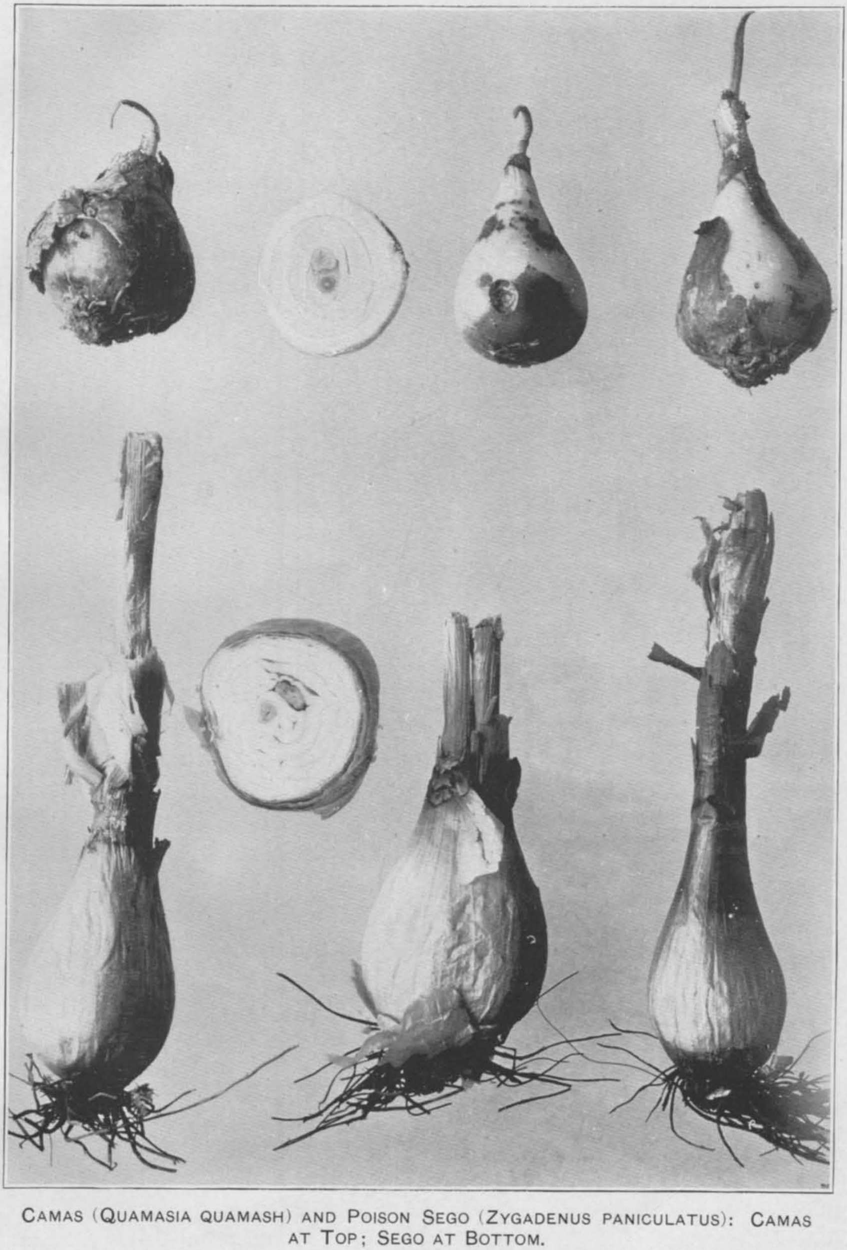
Fig. 42.—Death camas (*Zygadenus venenosus*).

Some botanists recognize at least six different species as native to the Northwest, but as only three of these have been extensively mentioned in any way, attention will be confined to them. The plant widely known throughout nearly the whole Pacific slope area as death camas (*Z. venenosus*, fig. 42) is very similar to two other species found in the Northwest, and to another, commonly known as wild sego (*Z. paniculatus*), which occurs in the great interior basin. As the two former have long been considered identical with death camas, and as they are all alike in the symptoms of poisoning which they produce, fig. 42 may well serve to illustrate all of them. Death camas differs from poison sego in its slender, instead of stout, habit, its unbranched inflorescence, and its long-clawed and obtuse-pointed petals, those of poison sego being acute-pointed and almost clawless.

Habitat and characteristics.—Death camas grows sparingly along creeks near the coast, and abundantly in the interior up to an altitude of nearly 9,000 feet, its favorite habitat being shallow depressions in mountain pastures into which there is a slow seepage of ground water. Poison sego grows in low, damp, alkaline depressions throughout nearly the same area, but it is most abundant in the Great Salt Lake Basin, where it ascends to an altitude of about 4,500 feet. The lower bulbs in Pl. XXXIV belong to this plant. The third species of poison camas (*Z. elegans*) is a much taller plant than either of the others. It is best known in the stock regions as alkali grass. It is most easily distinguished by its taller habit and the larger size of its various parts, especially of its flowers. It is a slender plant, which grows in moist alkaline places from northern California to Colorado, and northward to Alaska. It is never so abundant as either of the two preceding species. The leaves, and especially the bulbs, of these three species produce a foam when rubbed up with water, and they are generally more or less bitter, especially after long chewing. This taste is not, however, always present.

Many of the early explorers of the Northwest mention the bulbs of these plants as poisonous, this fact, in most instances, having been learned from the Indians, who were especially familiar with their deleterious properties, because they so closely resemble the edible bulbs of some plants which are known as camas and wild sego that the Indians themselves were, and still are, sometimes accidentally poisoned by eating them. It is for this reason that the plants have been called poison camas and poison sego. The true camas is a plant, the bulb of which is very extensively eaten by the Northwestern Indians. It resembles the death camas closely, especially in the character of its bulbs, as may be seen from Pl. XXXIV, the bulbs in the upper part being those of the true camas (*Quamasia quamash*) and those in the lower part belonging to poison sego. When in flower the former is easily distinguished from death camas by its showy blue flowers. All of the species of poison camas have several characteristic layers of a papery, onion-like skin on their bulbs, as shown in the illustration (Pl. XXXIV) for poison sego.

Names by which the plant is known.—Sego is a name which the Indians of Utah and the adjoining region attached to a liliaceous plant more commonly known as one of the Mariposa lilies (*Calochortus nuttallii*), the bulbs of which often furnished them with an abundance of food. It is a very pretty plant, which may be readily distinguished from death camas by its white, purple-spotted flowers,



CAMAS (QUAMASIA QUAMASH) AND POISON SEGO (ZYGADENUS PANICULATUS): CAMAS AT TOP; SEGO AT BOTTOM.

[One-half natural size.]

which are tinged with greenish yellow or lilac. Except in its bulb, it has no resemblance to death camas.

Several other names have been applied locally to the species of poison camas. Dr. J. R. Walker, physician of the Pine Ridge Agency of South Dakota, who furnished the Division of Botany with the symptoms in the case of an Indian who was fatally poisoned recently by eating some of the bulbs, stated that the Ogalalla Sioux name is *peji wakan*, which, being translated, means "mystery grass." The real significance of the name was not ascertained. The name "hog potato" has been given in Sonoma County, Cal., to the common death camas, because, according to Dr. Bolander,[1] the bulb "is greedily eaten by hogs" in that region. "Lobelia" is a name commonly but erroneously applied to the same plant in Nevada and Oregon to indicate its poisonous character. It causes vomiting in man, as the true lobelias do.

Poisonous character of the plant.—The earlier reports naturally refer almost exclusively to human cases of poison. It has been but a few years since any of the plants have attracted much attention as being fatal to stock. It has been stated, as noted above, that the bulbs are not poisonous to hogs, but they are very commonly considered fatal to other stock. Prof. F. H. Hillman[2] has published two brief accounts illustrating the wild sego (*Zygadenus paniculatus*) and suggesting that this plant is probably responsible for the death of a considerable number of cattle in certain alkaline districts of that State. So far as the writer is aware, however, no toxicological experiments were made prior to 1900 with any of the species which proved their poisonous qualities. The experiments made by Dr. S. B. Nelson[3] at Pullman, Wash., were wholly negative in result. A pound of the plant, in blossom and fruit, was fed to a sheep during the course of about twelve hours without causing any marked ill effect. In the spring of 1900 Dr. Wilcox and the writer, independently of each other, made several tests on rabbits and sheep, both with extracts and fresh plants, and none of these failed to give some positive evidence of the physiological activity of the plants. In every case, even in the feeding experiments, however, the animals received nearly all the material given them within a few minutes, and, moreover, most of the plants used were not yet in flower. This may account for the difference of our results from those of Dr. Nelson, or it may possibly have been due to a difference in the species used. The latter can hardly be the case, however, for the same species has proved poisonous in a number of cases which occurred in Oregon and Washington under the usual conditions. The difference is mostly attributable, therefore, to the

[1] Brewer & Watson, Botany of California, Vol. II, p. 183, 1880.
[2] Nevada Experiment Station, Newspaper Bulletins Nos. 5 and 21, 1893 and 1897.
[3] Bureau of Animal Industry, U. S. Dept. of Agr., Bulletin No. 22, p. 13, 1898.

difference in the rate of feeding and to a possible difference in the toxic character of the plants at the different stages of growth at which they were used. It may, however, be possible that the Washington animal was older than ours and had previously accustomed itself to the plant.

When dangerous to stock.—Stock are poisoned by eating the bulbs along with the leaves, or by the leaves alone while at pasture, or by the seeds when present in hay, as they sometimes are. As a rule, the bulbs can not be pulled up by stock in the act of grazing, but after the ground has been thoroughly soaked with rain they may be, and sometimes are, so extracted. Stock, especially sheep, are usually killed by eating the plant before it has blossomed in the spring. The leaves appear early, and are then very tempting to stock on account of their succulent condition and also on account of the lack of other herbage. After the plants have blossomed, which, with the species growing on the feeding ranges, occurs about the 1st of June, the leaves dry up, as shown by the right-hand plant of fig. 42. They are then very uninviting in appearance and are probably never eaten by stock. Whether or not all or any of the species are nonpoisonous at that stage of growth is a matter which has not been determined. It is very doubtful if such is the case. There is a popular belief to this effect, but it appears to be certain that the seeds of at least one species—the Great Basin plant—kill stock when eaten with hay. It is very doubtful if the plants are eaten on the range in a nearly mature stage of growth. The absence of heavy rains on the ranges in summer precludes the possibility of stock being poisoned by eating the bulbs during that period. There are some general grounds for the belief that the bulb is the most poisonous part of the death camas, but no experiments have been made to show that such is the case.

Reports of the poisoning of stock from one or another species of poison camas while grazing have been sent in to the Department of Agriculture from nearly all parts of the Northwest. The only cases of poisoning from hay have been reported from Nevada. These were due to the seeds of poison sego. Most cases were, however, caused by death camas, which is by far the most widely known species.

Damage caused.—Poisoning from this plant is so common in Oregon and Nevada that the term "lobeliaed" has been invented to indicate the resulting death or symptoms of poisoning. In Montana as many as 3,030 one-year-old and two-year-old sheep were reported to have been poisoned by death camas during the spring of 1900. Two thousand of these were poisoned in a single band. Over 21 per cent of the total number died. The money value of the total loss from poison camas in the Northwest has not been estimated, but must be considerable. The losses noted by Dr. Wilcox and the writer in Montana during the spring of 1900 were due to but one species and amounted to nearly $2,000.

SYMPTOMS OF POISONING.—The symptoms of poisoning, as reported by stock owners, are practically the same for all of the species. As observed by Dr. Wilcox and the writer in the case of sheep, the most prominent symptoms in the early stages were uneasiness, staggering, frothing at the mouth, continued regurgitation, and labored, irregular breathing. The difficulty in the breathing was prominent until death, but the rate became fast and the inhalation exceedingly shallow. The later stage was sharply distinguished, both from the symptoms of the early stage and from those observed in the different stages of water hemlock and larkspur poisoning, by the almost complete collapse of nervous energy, the animals often lying on the side, apparently dead, for many hours. The pulse remains nearly normal throughout, the functions of the brain are not much impaired, and there is little disturbance in the digestive system except in the case of very young animals poisoned by the milk of their mothers. These lambs frequently die from an acute attack of dysentery within a few hours after sucking. Adult sheep also die inside of two or three hours when a considerable quantity of the plant is eaten, but they often live from two to three or four days when a small quantity is consumed.

The symptoms in horses and cattle have not been well described. Both animals are killed by eating the plants, but horses, it is said; are more apt to recover. According to the accounts of a few stockmen, the action seems to be more violent in the case of horses and cattle than in that of sheep, spasms being mentioned as a prominent characteristic for both. This is also the case with rabbits.

EFFECT OF THE POISON SHOWN BY POST-MORTEM.—The post-mortem examination of sheep which have died from eating death camas reveals, as in cases of larkspur poisoning, no important changes in any of the internal organs excepting the heart and lungs. These are filled with dark, unaerated blood, as is also the case in larkspur poisoning. Cases may be easily diagnosed by the character of the contents of the stomach, which nearly always contains undigested fragments of the plants eaten.

NATURE OF THE POISON CONTAINED IN THE PLANT.—The identity of the toxic substance in the various species of poison camas has not been determined. It seems probable that it may be a sapotoxin-like substance, as its frothing action suggests, but it may be an alkaloid similar to that of veratrine found in the various species of veratrum, which are closely allied plants. The physiological action of veratrine is somewhat similar to that caused by the active principle of poison camas. The latter is very fatal, especially when given hypodermically. Experiments made on rabbits and sheep show that the aqueous extract from 7½ grains of the fresh leaf is the fatal dose per pound weight in rabbits when given hypodermically, and that the fatal feeding dose of the fresh plant with roots attached is from a half pound to 1 pound (about 30 to 60 plants) for a sheep weighing about 70 pounds.

Remedies.—Salt, soda, and lard or fat pork are the remedies usually applied by the stockmen in cases of poisoning from these plants, but the results are not satisfactory, and it has been claimed that there is no known antidote. Hypodermic injections of strychnine and atropine, both alone and together, with morphine, were tried by Dr. Wilcox and the writer without success, but the feeding of a permanganate mixture, similar to the one already recommended in the case of poisoning by larkspur, yielded excellent results, even when administered long after the first symptoms were observed. Its administration, as already described, is to be recommended at all stages of the poisoning, but it is advisable also to use stimulants in the more advanced stages.

The best preventive.—It is practically impossible to eradicate a plant which, like the death camas, densely covers thousands of acres of prairie land, but it may sometimes be practicable to remove it from small areas by pulling up the bulbs. The best thing for stockmen to do is to avoid, especially in early spring, the areas where the plants are abundant. For this purpose a thorough knowledge of the plants in their earlier stages of growth and of their habitat is essential.

# HOT WAVES: CONDITIONS WHICH PRODUCE THEM, AND THEIR EFFECT ON AGRICULTURE.

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## GENERAL REMARKS ON DAMAGE CAUSED BY HOT WAVES.

Of all adverse weather conditions, those accompanying periods of long-continued high temperature are perhaps the most detrimental to man's mental, physical, and financial welfare. A summer hailstorm may destroy considerable property over a limited area, a high wind may cause damage of more serious nature, and a tornado is still more destructive to property and is usually accompanied by loss of human life; but all these are local in their effect, and their duration is only for a short period. Even a hurricane sweeping up from the West Indies, carrying death and devastation in its path, affects but a relatively small portion of the United States; a general hot wave, however, with its blighting and death-dealing temperatures, leaves a trail of ruin so widespread and so great that it can not be accurately measured. To be sure, estimates can be made of the injury to growing crops, and these alone make an astounding figure. The loss to the State of Iowa on account of a hot wave which visited that section in the latter part of July and early portion of August, 1894, amounted to over $50,000,000,[1] a property loss nearly twice as great as that caused by the Galveston hurricane in 1900; and these are the figures for only one State.

As for the suffering undergone by the millions of humanity day after day in these hot-wave periods, there is no record, nor is one possible. Statistics may be secured as to the number of sunstrokes, but no data are obtainable regarding the sick whose deaths are hastened by the abnormally heated atmosphere.

Of the great crops of the country, corn and cotton are most liable to injury through overheating. The damage that results from this cause is at times appalling. In most cases the mere lack of rain is but partially responsible for the blight, as it is found that the cooking, firing effect of the intensely heated atmosphere is the source of much irretrievable damage. When affected by drought alone most crops will

[1] The average value of Iowa crops for the three years prior to 1894, as reported by J. R. Sage, in the Iowa Climate and Crop Reports for 1891, 1892, and 1893, was $181,926,432; while for the year 1894, according to the same authority, the value of Iowa crops was $121,284,696, or more than $60,000,000 below the average. The hot wave coming at a critical period was almost wholly responsible for this diminished production.

rapidly revive if favorable weather follows in a reasonable time, but once the life-giving properties are destroyed by excessive heat no amount of properly distributed rainfall or sunshine can repair the injury. Conservative farmers in the West estimate that during a summer of average heat the damage resulting on account of occasional seasons of high temperature, covering a period of from three to six or more days, reduces the yield fully 20 per cent below what it would be under favorable circumstances.

### PERIODS OF OCCURRENCE OF HOT WAVES AND CHARACTER OF INJURY CAUSED.

In this discussion a hot wave is regarded as a period of three or more consecutive days, during which the maximum temperature reaches or passes 90°. With but a few minor exceptions, these periods are found to occur in the months of June, July, August, and September.

#### JUNE PERIOD.

In June, as a rule, the hot waves are less frequent and not as severe as later in the season. The heat is less intense, as the cumulative effect of the summer season has not reached its maximum. In the farming districts of the West it is generally a month of abundant moisture. For most cereals an excess of heat at this time is the one thing most needed, corn and kindred crops being especially benefited. The oat crop, however, is frequently endangered and often seriously damaged by rust caused by a combination of excessive precipitation and too much heat. Under these conditions the oats fail to fill and the yield is light and its value greatly impaired. Fruits which ripen during this month, if superheated, are also greatly injured.

#### JULY AND AUGUST PERIODS.

In the latter part of July and early August, crops which mature in the fall are most susceptible to permanent injury. It is at this time that the summer excess of heat is greatest and such precipitation as occurs falls during thunderstorms or in showers, so that the heat of the atmosphere is not materially lowered thereby. It can readily be seen that this is a most critical time with the farmer. When for any reason the cumulative heat tendencies are exaggerated above the naturally high normal, the result is most disastrous to the agriculturist. The corn withers and fires, the leaves curl up and become lifeless, the growth of the ear is stopped in its infancy, and the efficacy of the pollen is destroyed. No amount of favorable weather after such a period is effective in revivifying the blighted crop. Nubbins and small ears are the best that may be expected. The effect on cotton is equally injurious. After passing through a period of abnormally hot temperature at this season, the yield is of such poor quality and such small quantity as scarcely to pay for the picking, and many fields are abandoned on that account. Pastures, and grass products in general, suffer even more. If the hot wave is unusually severe it is found that the life has been baked out of the roots, and it is often necessary to plow under an otherwise good pasture, because the grass was killed the preceding summer by the torrid weather. The severe drought with its evil effects on vegetation is not lost sight of, but investigation lends color to the belief that the drought is only a contributing influence and not the principal factor in the damage caused. When the temperature reaches a point where the leaves on the trees begin to curl up and drop, despite the moisture supply of the roots, the cause must be assigned to other reasons than a mere lack of rainfall. Such results frequently follow, or are coincident with, hot waves.

### SEPTEMBER PERIOD.

During September the principal deteriorating effect of a hot wave is to push crops too quickly to maturity, thus causing an injury to the soundness of the grain and lowering its keeping qualities. Apples and other fruit drop to the ground or begin to rot while still on the trees. However, a hot wave in September is not always detrimental. It is sometimes the means of the salvation of a large portion of a crop which may need a great deal of heat in order to properly mature it before frost arrives. The absence of a hot wave at such a time amounts to almost as great calamity as its presence earlier in the season.

### SUMMARY OF HOT WAVE RECORDS.

Taken as a whole, the harvest returns for years during which hot waves were unusually severe show a production of one-fourth less in quantity, the quality being quite inferior to the standard. However, during the years immediately following such seasons the yield frequently reaches a maximum for the decade. Frequently the hot weather of one summer is of material benefit in preparing the soil for an unusually large crop the following season. It seems to have the effect of making the ground mellow and putting it in an ideal condition for the reception of seed.

A careful study of the records of the Weather Bureau covering a period of thirty years fails to reveal the regular recurrence of summers of excessive heat, or that hot waves occur on the same days in succeeding years. The table following (p. 328) gives the departures from the normal temperature of the four summer months, June, July, August, and September, at eight widely separated stations of the Weather Bureau, thus showing representative conditions over the entire country.

*Departures from the normal temperature during June, July, August, and September for a period of twenty-nine years, reported from eight stations, as shown by the records of the Weather Bureau.*

| Year. | Boston. | Washington. | Charleston. | Memphis. | Cincinnati. | Denver. | Santa Fe. | Omaha. | Average. |
|---|---|---|---|---|---|---|---|---|---|
| | ° | ° | ° | ° | ° | ° | ° | ° | ° |
| 1872.... | +2.1 | +3.5 | +1.6 | +0.8 | +1.7 | −0.4 | +0.4 | +0.7 | +1.3 |
| 1873.... | +0.3 | +1.9 | −1.0 | −0.6 | +1.5 | +0.2 | −0.2 | +0.4 | +0.3 |
| 1874.... | +0.1 | +1.8 | −0.4 | +2.1 | +3.8 | +2.0 | +2.8 | +1.8 | +1.8 |
| 1875.... | −1.0 | +2.7 | −2.2 | −1.4 | −1.9 | −0.2 | −0.7 | −2.0 | −0.8 |
| 1876.... | 0.0 | +1.3 | +1.8 | −0.5 | +1.3 | +0.7 | −1.1 | −1.8 | +0.2 |
| 1877.... | +0.3 | +1.1 | +1.6 | −0.6 | +0.5 | +0.4 | +1.2 | −0.4 | +0.5 |
| 1878.... | −0.4 | +0.1 | +0.8 | +1.2 | +1.0 | −0.1 | +0.1 | +0.8 | +0.4 |
| 1879.... | −1.7 | −0.7 | +3.1 | −1.0 | +0.3 | +1.3 | +2.0 | +0.6 | +0.5 |
| 1880.... | +0.4 | +0.5 | +0.8 | −1.5 | +1.1 | −0.4 | −1.4 | +0.3 | 0.0 |
| 1881.... | −0.7 | +2.1 | +2.5 | +3.7 | +4.1 | +2.3 | +0.2 | +3.4 | +2.2 |
| 1882.... | +0.2 | +0.1 | +0.5 | −1.4 | −0.7 | 0.0 | −0.3 | −0.8 | −0.3 |
| 1883.... | −0.5 | −1.0 | +0.3 | −1.0 | −0.8 | +0.3 | ........ | −0.4 | −0.5 |
| 1884.... | −0.3 | +0.1 | −0.7 | +0.6 | +1.7 | +0.9 | ........ | −0.2 | +0.3 |
| 1885.... | −0.9 | −1.0 | +0.4 | +0.9 | −2.1 | −1.5 | −0.1 | −1.1 | −0.7 |
| 1886.... | −1.2 | −1.5 | −1.3 | −0.6 | −1.7 | −0.1 | −1.3 | +0.5 | −0.9 |
| 1887.... | −1.1 | −0.4 | −1.0 | +0.2 | +1.7 | −0.2 | −0.1 | +0.1 | −0.1 |
| 1888.... | −1.5 | −2.3 | −4.0 | −2.0 | −3.1 | −1.0 | +0.2 | −1.8 | −1.9 |
| 1889.... | −0.1 | −1.9 | −1.2 | −1.4 | −2.4 | 0.0 | +1.6 | −1.1 | −0.8 |
| 1890.... | −0.5 | −0.3 | 0.0 | +0.5 | 0.0 | +1.0 | +0.2 | +0.1 | +0.1 |
| 1891.... | +0.4 | −1.0 | +0.2 | −0.4 | −1.3 | −1.1 | +0.5 | −0.9 | −0.3 |
| 1892.... | +1.5 | +0.5 | −0.7 | −0.6 | +0.3 | +1.0 | +2.2 | +0.6 | +0.3 |
| 1893.... | −0.9 | −0.6 | +0.3 | +0.2 | +0.9 | +1.3 | +0.2 | +0.8 | +0.3 |
| 1894.... | +1.5 | +1.1 | −1.1 | +0.2 | +1.8 | +1.3 | −0.8 | +3.2 | +1.0 |
| 1895.... | +0.9 | +1.1 | +0.9 | +1.4 | +1.9 | −1.3 | −0.3 | +1.0 | +0.7 |
| 1896.... | +1.1 | −0.2 | +0.8 | +1.2 | −0.8 | +0.8 | +1.2 | −1.1 | +0.4 |
| 1897.... | −0.7 | −1.1 | +0.4 | +2.2 | +0.4 | +0.3 | −0.1 | +2.9 | +0.5 |
| 1898.... | +1.9 | +1.9 | +1.0 | +1.3 | +2.5 | +1.0 | +0.3 | +2.1 | +1.5 |
| 1899.... | +1.1 | −0.2 | +1.0 | +1.2 | +1.0 | +1.0 | +1.8 | +1.0 | +1.0 |
| 1900.... | +1.1 | +2.9 | +2.0 | +1.7 | +2.7 | +2.5 | +0.0 | +2.0 | +1.9 |

The conclusion then is that these visitations may be expected at irregular intervals, the number and intensity of which vary greatly from year to year. It is also found that the extreme maximum occurs within a day or two after the first 90° is recorded. This extreme temperature in regions north of the thirty-seventh parallel sometimes passes the 100° mark, and almost always approximates that point. The number of successive days of abnormal heat varies, and may range as high as sixteen or seventeen. Again, two or more periods may come in close succession, and in the popular mind these are associated as one long spell, as, for example, the month of August and first part of September, 1900. It is the exceptional summer when at least one of these hot waves does not sweep across the country, but the number to be expected in any one season is uncertain. As before stated, fewer hot waves occur in June than in any other of the summer months. July furnishes the greatest number, while

August and September are not far behind. In the last two the period covered is likely to be longer than in the earlier part of the season.

SECTIONS AFFECTED BY HOT WAVES.

At times only one section of the country is affected; on other occasions large areas, covering half the United States, are held in the grasp of the hot wave. No section entirely escapes, although the conditions vary in different portions. In central California, eastern Oregon, and eastern Washington the local surroundings are favorable for long-continued periods of excessive heat, as ideal "summer conditions" exist in these places. There is an almost total absence of rain, and the summer drought brings with it temperatures that frequently pass the 100° mark on several consecutive days. On the Great Plains of the Middle West the most severe effects of the hot wave are noticed. It is in this section that the hot wave frequently has its birth. It is often attended by hot winds, which bear a relation to the hot wave not unlike that of the tornado to the general cyclone. These hot winds are a constant menace to the crops of the Western prairies. In many instances fields which promised abundant yields have been injured beyond recovery in a single day. To the eastward of the Great Plains the hot wave is not so severe with regard to its extreme temperatures, but it is usually of longer duration. The effect on vegetation is less marked, although on account of the higher relative humidity the discomforts to man are much greater. In the South the conditions are of a semi-tropical nature, the changes being less frequent and the diurnal range less. This is partly due to geographical position and partly to the fact that the storm tracks pass far to the north, and their influence is but little felt in this region. The South does not entirely escape, however, and at times suffers severely from the abnormal heat.

In the Ohio Valley, Tennessee, and the Atlantic coast States the duration of the hot wave reaches a maximum, at times embracing a period of two and even three weeks. The extreme temperature is lower than on the Western prairies, but the mean is higher and the diurnal range much less. During these periods, when the maximum temperature is above 90° daily, the minimum rarely registers lower than 70°, and frequently not that low. To this latter fact may be traced the intense suffering of those who are compelled to live in the large Eastern cities, where the street temperatures are higher than those recorded in the Weather Bureau observatories. On account of the proximity to large bodies of water the region surrounding the Great Lakes, as well as New England, is largely free from severe hot waves. The frequent passage of storm centers over these sections keeps the air in circulation and prevents stagnation, which latter seems to be an essential factor in the evolution of a hot wave. Along the coast line hot waves are practically unknown, due, no doubt, in a large measure to the land and sea breezes which tend to keep the temperature lower than farther inland.

### METEOROLOGICAL CONDITIONS PRODUCING HOT WAVES.

A study of the meteorological conditions under which hot waves occur reveals a certain type of influences which may be said to be characteristic of this phenomenon. This is the so-called "summer type," under ideal surroundings, existing over a series of days, that is, it is the ideal summer conditions in a state of stagnation, and it is only when there is this stagnation that the hot wave manifests itself. When the normal circulation of the atmosphere is resumed the heated term comes to a close. It should be understood, however, that this stagnation, while marked, is but relative, as the area of high temperature usually slowly drifts from west to east and is finally driven off to sea by the advent of a marked area of high pressure, causing a complete change in barometric and thermal conditions.

### WEATHER CONDITIONS DURING A JUNE HOT WAVE.

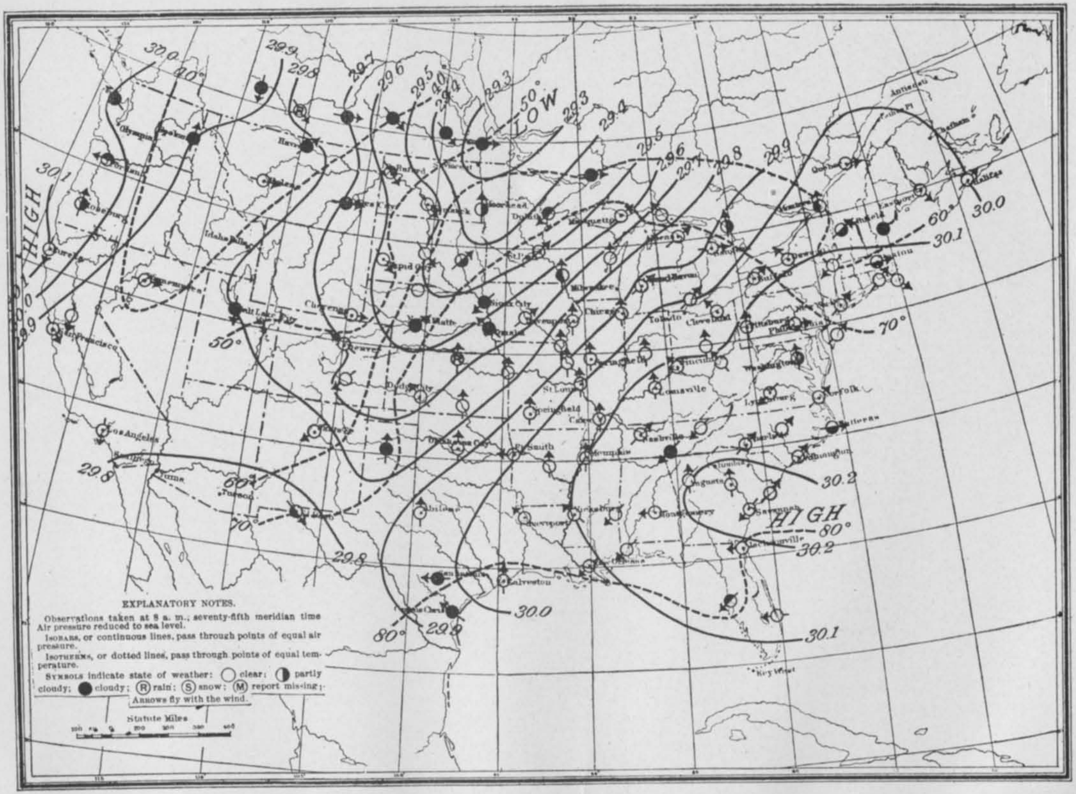
From June 20 to 30, 1890, the Mississippi Valley and the Gulf States were visited by a well-marked hot wave. In fact the entire central portion of the country was within the circle of its influence. During this period a high pressure was constantly present off the north California coast, and during most of the time a second high hung over the South Atlantic and Gulf States. Situated in the Great Plains was an almost stationary trough of low pressure, with an average reading of 29.7. Over the region most affected occurred a series of clear days and cloudless nights, attended by a uniform but light wind from a southerly direction. In the neighborhood of the Lakes the temperature remained quite moderate, the weather being cloudy, with occasional showers, and the winds generally from a northerly direction.

During the continuance of this hot period the 80° isotherm, as shown by the 8 a. m. observation, frequently extended above the Ohio River, and at times as far north as central Iowa. The barometric changes from day to day were inconsequential and the general stagnation of the air was plainly evident. No general storm moved across the country, although several skirted the northern edge and affected somewhat the conditions over the Great Lakes. While the low pressure remained over the Great Plains and the high was located to the southeast over the South Atlantic States, the hot wave continued. It was only when an area of high pressure appeared in British Columbia and drifted southeastward into the United States that the stagnation was broken up and the temperatures were reduced to their normal stage.

Pl. XXXV is a chart of the weather conditions as observed at 8 a. m., June 25, 1890, which will give an idea of the conditions prevalent during this period. On the day previous to the one on which


WEATHER MAP OF 8 A. M. JUNE 25, 1890.

PLATE XXXVI.




WEATHER MAP OF 8 A. M. SEPTEMBER 20, 1895.

Yearbook U. S. Dept. of Agriculture, 1900.

these observations were taken the maximum temperature registered 90° or more at almost all of the stations situated in the Ohio, Mississippi, and Missouri valleys and the Rocky Mountain plains. This is what might reasonably be expected in view of the season and the distribution of barometric pressure.

### WEATHER CONDITIONS DURING A SEPTEMBER HOT WAVE.

A severe hot wave which occurred late in the season was that of September, 1895, which prevailed over the central and eastern portions of the country from the 10th to the 23d of that month. On account of the approaching winter season the gradients were steeper than usual during hot waves and the movements of the atmosphere not so sluggish. For several days prior to the commencement of the excessive temperature a high pressure of moderate intensity was present over the Southeastern States, its stagnated condition indicating that it formed a part of the great permanent South Atlantic high. The weather was generally clear over the territory east of the Rocky Mountains and south of parallel 45. The direction of the wind was from the center of the high northward and northwestward. After forty-eight hours' continuous flow of this warm stream of air from the south a low area began to form near the Canadian line. This increased rapidly in intensity, attaining a pressure of 29.1 at its center, at that time located over the Dakotas. During the ensuing week this depression drifted slowly eastward, followed closely by a high area, which had appeared over the Puget Sound region. In the van of the low, temperatures were from 10° to 20° above normal. The center of extreme heat was first located in the West, but it slowly moved eastward, keeping slightly in advance of the low area. Although the Pacific coast high was well marked and the temperature range sharp, its action was not as vigorous as would be expected. After several days, however, it had reached northern Texas, bringing with it temperatures close to the freezing point, while in the East the thermometer registered well into the nineties. From Texas northeastward the movement of this anticyclone was greatly retarded, the influence of the high in the Southeast being still strongly felt. The severity of the hot wave was increased by the absence of precipitation, the records showing little or no rainfall during this period in the region affected. The absence of this disturbing element permitted the heat to accumulate from day to day and made the dissolution of these conditions difficult to accomplish.

In Pl. XXXVI, which is the 8 a. m. weather map for September 20, 1895, may be seen characteristic conditions for this period. The official synopsis for that day contained the following statement:

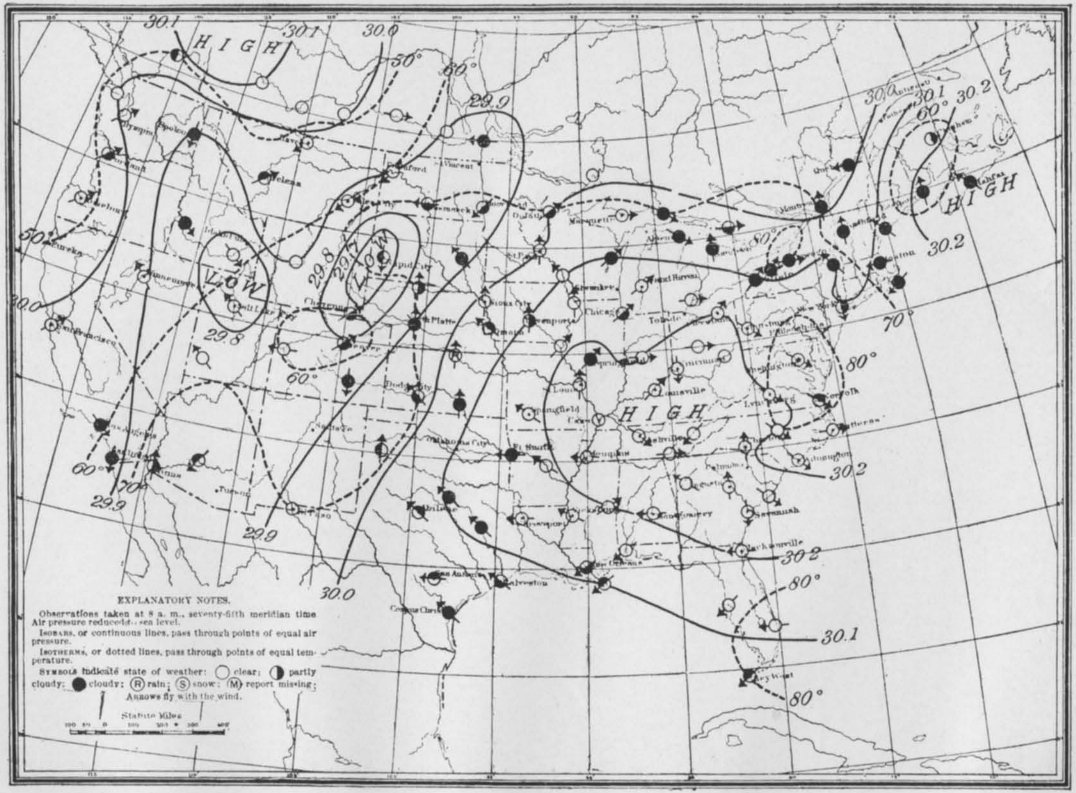
> The excessive heat which has prevailed during the past week throughout the central and western portions of the country continued yesterday, with maximum temperatures generally above 90°, although the extremes were slightly lower than on

the preceding days. Heated conditions have extended eastward over North Carolina, Virginia, and the District of Columbia, maximum temperatures of 96° occurring at Charlotte, N. C., and Washington, D. C.; 98° at Raleigh, N. C., and 100° at Norfolk and Lynchburg, Va. These temperatures were from 2° to 9° above the record in any previous year for the second ten days of September.

WEATHER CONDITIONS DURING THE HOT WAVE OF AUGUST–SEPTEMBER, 1900.

The hot wave of August–September, 1900, will long be remembered on account of its length and intensity. In the East it was especially severe, although its influence extended westward beyond the Mississippi River. From the 5th of August until the 10th of September there were but three or four days when the maximum temperature did not equal or exceed 90°, so that this entire period may be regarded as continuous, so far as its effect on mankind is concerned, although in a meteorological sense it was divided into at least two distinct periods. The conditions were not unusual, the lack of movement of the South Atlantic high being the most marked feature. The hot wave had its inception in the wake of a high area, which dropped down from northern New York over Virginia and the neighboring States. Here it seemed to join forces with the permanent high over the ocean and remained nearly stationary for a number of days. Its center was further inland than ordinarily, indicating the presence of an unusually large high to the eastward. This oceanic high doubtless acted as an insurmountable barrier to the eastward flow of the atmosphere, thus closing the outlet for the escape of warm continental air, which, thus confined, maintained its high temperature for a long period. The fact that the minimum temperatures were the highest of the year lends color to the theory that the introduction of new and fresh air had almost ceased, thus preventing the cooling of the air at night.

The winds blew out radially from the center of the high, their velocity being quite low. In the Upper Mississippi and Missouri valleys was located a low area into which the hot winds from the high constantly poured. The precipitation was much below the normal during the greater portion of the time, except along the Canadian border from Minnesota eastward, where cloudy weather with heavy showers predominated. In western California and Oregon the oceanic high pressed slightly into the interior. As the days passed the energy of the South Atlantic high slightly diminished, a tendency to drift southward being manifest. While the high was passing over Washington, D. C., moderate temperatures prevailed, but as soon as the pressure began to fall temperatures began to rise. After the area of high pressure came the period of high temperature from the 6th to the 12th. During this time the skies were mostly free from clouds. A few ragged cumuli formed and hung listlessly around the horizon, disappearing by sunset. The barometer rose and fell with the regularity of the tide, its action on this occasion being not unlike that in the calm




WEATHER MAP OF 8 A. M. AUGUST 8, 1900.

and tranquil atmosphere of the Tropics. On the approach of the tropical storm from the West Indies about September 1, the anticyclone was still of such strength as to act as a barrier to the northward progress of the hurricane, which was deflected into the Gulf of Mexico and finally reached Galveston, bringing with it death to thousands of people and destruction to millions of property. Leaving the Texas coast, the storm passed rapidly northward into Iowa and from thence northeastward over the Great Lakes and the St. Lawrence Valley. It carried with it much of the stagnant heated air which had accumulated in the Eastern States and most completely brought to an end the insufferably hot weather of the preceding six weeks.

Pl. XXXVII shows the conditions existing at 8 a. m. August 8, 1900, and is a typical map for this period. Temperatures ranging from 96° to 100° were recorded the day previous, as well as on that particular day and the several following, in North Carolina, Virginia, District of Columbia, Maryland, and Pennsylvania.

GENERAL WEATHER CONDITIONS TO BE EXPECTED DURING HOT WAVES.

From the above three periods, a general idea of weather conditions to be expected during hot waves can doubtless be obtained. The location of the center of extreme heat will generally be found on the northern and western outskirts of the high pressure. The distribution of pressure will be about such as has been described. The longevity of the hot wave seems to depend upon a slacking up in the general circulation. Aside from the direct heating from the sun, dynamic heating and lack of radiation have an important influence in maintaining the temperature at an abnormal figure. At such times the atmosphere becomes heated to a much greater altitude than usual, the heat being retained at night by conditions explained further on in this article. The air which flows eastward across the Rocky Mountains and into the low has been bereft of its moisture, and on descending into the lowlands gains heat dynamically. The air emanating from the high in the southeast goes through much the same process. The clear days warm up the atmosphere and at night the radiation is greatly impeded. Ferrel and other meteorologists of repute have determined that the increase in heat of descending currents of air is at the rate of 1° C. for each 100 meters, which is equivalent to 1° F. for each 183 feet. When it is considered that there is a steady flow of air outward from the center of the high, the presence of this descending current is clearly demonstrated. In the case of the high over the South Atlantic States, at such a time it forms part of the great subtropical high, which is composed largely of relatively highly heated air which has drifted northward from the equatorial region. As long as this unfailing source of heat supply is uninterrupted, the stream of hot air continues to flow out from the center until the advent of an anticyclone of superior energy sufficient to bring about new conditions.

Professor Bigelow, in Bulletin No. 20 of the Weather Bureau, "Storms, storm tracks, and weather forecasting," says:

> The excessively hot spells of weather that cover the Atlantic States during certain intervals are attended by a high area on the South Atlantic coast, being a portion of the great subtropical high. Aside from the transportation of warm air from Southern to Northern latitudes, there must be a downpouring of dry hot air in the high itself, due to the excessive "potential" temperature of the upper strata.

Speaking of the hot waves of August, Professor Bigelow says:

> These come from two sources: They originate in a mass of heated air on the Rocky Mountain plains and gradually move eastward from thence; on the other hand, a high area settling over the South Atlantic and Gulf States has the effect of charging the stagnant air with heat, as if the eastward circulation in the upper air was suspended for quite long intervals of time.

One of the peculiar features of the hot-wave period is that, notwithstanding the cloudless nights ordinarily favorable for radiation, the air retains its heat in a manner that seems little short of remarkable. For some reason the normal radiation is greatly impeded and almost totally suspended. The exact cause of this cessation of normal action has not been definitely determined, although the investigations of Professor Very have shed much new light on the subject. In his report on "Atmospheric radiation," recently published by the Weather Bureau, he states that this condition is brought about by the gradual accumulation of water vapor in the upper air, which, although not sufficient to form clouds, is of such a nature as to transmit the rays of the sun with greater readiness than the reflected rays from the earth. This has the effect of accumulating the heat in the lower strata, causing the night temperature to be unseasonably high. At such times the diminution of the daily range of temperature with a clear sky, as saturation approaches, is probably due to a change in the quality of aqueous absorption, and also to the increase of water vapor and its ascent to exceptional heights in considerable quantity, whereby the escape of radiation is impeded by the strong aqueous absorption of the infra-red rays between $5\mu$ and $8\mu$ (that is, the invisible heat rays of the spectrum between which the absorption of water vapor is greatest) not far from the point where the maximum energy in the radiation from bodies at ordinary temperature resides. The presence of large masses of water vapor in the upper air may not always be indicated by high relative humidity at the surface any more than by clouds, but it is evidenced by the strengthening of the rain band, as seen in the spectroscope, as well as the diurnal range of temperature. Professor Very states that—

> The heat entrapped through the differential transmission of solar and terrestrial radiation by aqueous vapor and carbon dioxide is mainly stored in the lower layers of the atmosphere, and because the absorption by air heavily loaded with moisture is nearly complete for its own radiation, this stored-up energy continues for a long time as a controlling balance wheel in the mechanism of the weather. As long as

the mantle of water vapor remains unbroken thermal fluctuations are kept within narrow limits. Storms may make inroads upon the continuity of this aqueous atmospheric envelope, but evaporation of moisture restores the rents. Rolled up in great bosses covering hundreds of thousands of square miles of territory, the thickened mantle of vapor brings hot waves. The gradual accumulation of moisture in higher and higher atmospheric layers during the summer clothes the temperate regions with so deep a protective covering of moist air that summer conditions are prolonged in the autumn to a time which is astronomically the correlative of late winter. The absence of this protective layer, whose formation can only be effected gradually, permits late frosts in the spring, long after the sun has resumed his ascendancy. In the middle of a sunshiny day, by the evaporation of moisture from the earth's surface and its ascent in convection currents, the vapor of water is carried up to high levels, but during the night most of this accession of moisture is diffused into colder or drier regions of the upper air, where it is either condensed and no longer exists in the air as vapor or is so diluted and reduced in relative humidity as to be of slight absorptive value when the sun next rises.

The kite observations at Pierre, S. Dak., reveal the fact that just prior to and during periods of hot waves the upper atmosphere in the early morning is several degrees warmer than the layers adjacent to the surface of the earth, showing that the cooling process has extended upward but a short distance. There are a number of facts which seem to warrant the belief that the warm ascending air in the low is carried with but slight loss of heat to the center of the high, whence it descends, its temperature when it reaches the ground being quite high. The presence of a large number of dust particles in the upper air during such periods, attended by hazy conditions, seems to support this theory, although these phenomena may be due solely to local conditions caused by dry, dusty weather. On the other hand, it is held by some meteorologists that there is little actual interchange of air between adjacent highs and lows, that is, that the air which ascends in the low is not the same which later descends in the high, but that this descending air comes from other sources.

In the case of the South Atlantic high the source of supply is believed to be from the superheated air of the equator, which, upon being heated, rises and flows down the slope thus created, and is piled up in the region bordering on the thirtieth parallel. When a high drifts across the continent and settles over Virginia or the Carolinas it becomes a part of the greater high just described, and the descending currents of air in it are fed from the accumulated masses of relatively warm air in these upper strata. Thus, the great heat of the air blowing out from the high at the surface is satisfactorily accounted for. Whatever may be the cause, it seems certain that the upper air in the high is relatively warm, and that during hot waves radiation is retarded in the high by reason of the descending currents of warm air, and in the low by reason of the accumulation of water vapor. Thus, the temperature over the affected region is kept at a high point because the conditions which bring about increased heat are at a maximum and those which permit its dissipation are at a minimum.

### SUMMARY.

To sum up, it may be said that, with the present fragmentary knowledge of the basic cause of meteorological changes, we are confined to the statement, that during a hot wave the eastward circulation of the atmosphere, both upper and lower, is for the time being almost totally suspended, and that radiation is at the same time at a minimum. A careful study of the weather charts covering such periods leads to the belief that it is quite practicable to forecast high temperatures for a period of from four to five days, but predictions for a longer time are, for the present at least, the merest guesswork and not entitled to credence.

# THE VALUE OF POTATOES AS FOOD.

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## INTRODUCTION.

The potato, called in different regions white potato, Irish potato, English potato, or round potato, was first introduced into Europe between 1580 and 1585 by the Spaniards, and afterwards by the English about the time of Raleigh's voyages to Virginia. It is commonly believed to be a native of Chile. Wild potato plants closely resembling those cultivated to-day are still found there, though it is a fact worthy of mention that, as the potato has been modified by cultivation, it has largely lost the power of producing seeds, and the cultivated potato differs from the wild in seldom producing seed-bearing fruits. When first visited by Europeans, the aborigines in Chile and adjacent regions cultivated the potato for its edible tubers and had apparently long done so. It was probably introduced into the United States, especially into Virginia and North Carolina, toward the end of the sixteenth century. It is not surprising that the new food stuff should have grown rapidly into popular favor when we remember its prolific yield, superior keeping qualities, ease of propagation, and agreeable flavor.

## STRUCTURE OF THE POTATO.

The potato tuber is in reality a modified stem, being shortened and thickened to serve as a storehouse for reserve material for the propagation of new plants. The outer skin, which is dry in appearance and usually gray or brown in color, corresponds to the bark of the rest of the plant. The portion underneath the skin when exposed to the sunlight turns green and gives the potato an unpleasant flavor. The outer and inner skin are usually removed when the potato is peeled. The flesh makes up the bulk of the potato.

When a section of the potato is carefully examined, it will be seen that it consists of three more or less well-defined portions, namely, the skin, cortical layer or fibro-vascular layer, and the flesh, which is made up of the outer and inner medullary layers. The cortical layer, which is the portion lying immediately beneath the true skin, and which is sometimes designated as the inner skin, is slightly colored, containing practically all the coloring matter normally present in the potato, and, as already stated, is the part which turns green on continued exposure to the sunlight. This portion has some resemblance to the skin in general appearance, and is usually removed with the skin in preparing potatoes for the table. Fig. 43 shows a transverse and a longitudinal section of the potato.

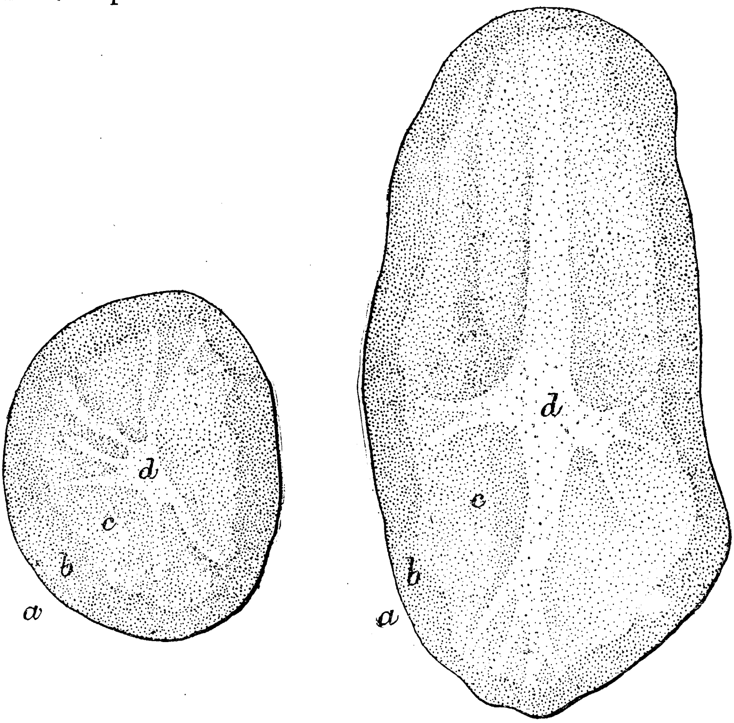


FIG. 43.—Transverse and longitudinal sections of the potato: *a*, skin; *b*, cortical layer; *c*, outer medullary layer; *d*, inner medullary layer.

## COMPOSITION OF THE POTATO.

The valuable qualities of the potato were speedily recognized, and there are early records of attempts to determine its food value by means of chemical analyses. In 1795 Pearson reported "Experiments and observations on the constituent parts of the potato root." Einhof, in 1805, published analyses of the potato, as did also Vauquelin in 1817. In America, analyses of the potato were reported some fifty years ago by Emmons. These investigations were useful at the time, although they were not made by the methods generally followed to-day. This was necessarily the case, as the subject of the chemistry of nutrition is of comparatively recent growth. In later years many studies of the composition and food value of the potato have been made in this and other countries.

As shown by recent analyses, the skin of the potato constitutes on an average 2.5 per cent of the whole and the cortical layer 8.5 per cent. It is difficult to peel potatoes so that the skin only is removed.

Whether both skin and cortical layer or only the former should be called refuse in our current sense of the word is perhaps a question. As potatoes are commonly eaten, a good deal of the flesh or edible portion is rejected with the skins. When they are baked with the skin on, much of the flesh is apt to be thrown away with the skin. When they are boiled with the skin on, the amount of edible portion thus thrown away may be very small. When they are pared for boiling, the amount wasted is apt to be much larger. When they are rough from defects in growth, or from shrinking and shriveling after keeping over winter, the amount of flesh cut off in the peeling is larger still. Just how much this loss of the edible portion of potatoes will average in ordinary households no one can say exactly. In the tables of analyses published in late bulletins of this Department, the amount of refuse and edible portion rejected with it is estimated at 20 per cent of the whole and the edible portion left as 80 per cent. Doubtless, in many cases the rejected portion is very much larger. The loss of actual

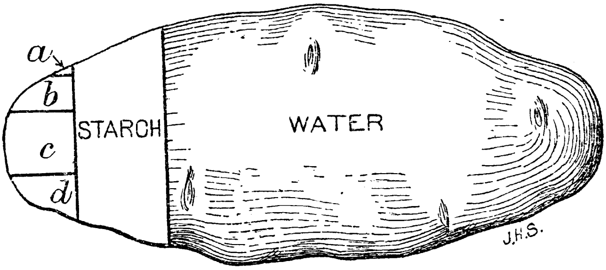


FIG. 44.—Composition of the potato: *a*, fat; *b*, crude fiber and other carbohydrates, exclusive of starch; *c*, protein; *d*, ash.

nutriment of the potato by the rejection of so much of the edible portion with the skin is a much more important matter from the standpoint of nutritive economy than people generally realize.

The edible portion is made up of 78.3 per cent water, 2.2 per cent protein (total nitrogenous matter), 0.1 per cent fat, 18.4 per cent carbohydrates (principally starch), and 1 per cent ash or mineral matter. Of the carbohydrates, 0.4 per cent is made up of crude fiber and materials which in some of their modifications constitute the cell walls of plants and give them a rigid structure. The above figures, like others for composition of food materials, represent general averages, from which there are wide variations in individual specimens. Though the skin, cortical layer, and flesh differ somewhat in composition, they all resemble more or less closely that of the whole tuber. Fig. 44 shows in graphic form the composition of the potato.

When potatoes are stored they undergo a shrinkage. According to tests made at the Michigan Agricultural Experiment Station, this amounted to 11.5 per cent when they were kept in storage from

September 30 to May 1. This shrinkage is probably due to a loss of water by evaporation.

The Connecticut State Agricultural Experiment Station has made a special study of the proteids of potatoes as well as of many other vegetable products. According to these investigations, the potato contains two proteids, a globulin, to which the name "tuberin" is given, and a proteose, the latter occurring only in very small amounts.

It will be remembered that food serves the body in two ways: (1) It is used to build and repair body tissue, and (2) it yields energy for internal and external muscular work and for maintaining the body temperature. Carbohydrates and fat are sources of energy and can not serve for the building and repairing of the body tissue. Protein is necessary for this purpose since it alone of the nutrients contains nitrogen, the characteristic element of the body tissue. In addition to this, protein also serves as a source of energy, and thus while the body could not be nourished on fat or carbohydrates alone, it could be, theoretically at least, on protein, since this nutrient combines the two functions of food. The potato contains some protein, but as the principal nutrient in it is starch, it may be fairly classed as a carbohydrate food. As is the case with all carbohydrate foods, it is chiefly valuable in the diet to supply the body with energy. The potato has a fuel value of 385 calories to the pound, that is, when burned in the body (as all foods must be when utilized), it yields energy equal to the amount named.

Of the total nitrogenous matter present in the potato, that is, the so-called protein, only a little over half, on the average, perhaps about 60 per cent, consists of true proteid, the portion of the protein group which actually builds the body tissues and helps to keep them in repair. The remainder consists of amids and other compounds of inferior food value. Thus, if 100 pounds of the edible portion of the potato contain 2.2 pounds of total protein, the amount of true proteid will be only 1.3 pounds. This deficiency of proteids in the potato is another matter which people generally do not appreciate. It helps to explain why large numbers of the country population of Ireland and Germany, whose food consists largely of potatoes, are so poorly fed. It is not so much the insufficiency as the one-sidedness of the diet. This is an illustration of the fact that no single article of diet is fitted properly to nourish adult man in health.

As appears from the figures quoted above, potatoes contain a large amount of water. It is largely present in the juice, which consists of water holding various salts and other bodies in solution. In their high water content potatoes resemble turnips and cabbages, which, on an average, contain, respectively, 89.6 and 91.1 per cent water. Ordinary roller process flour contains only about 12 per cent water and a much larger proportion of protein, fat, and carbohydrates than potatoes.

Rice also contains about 12 per cent water. Although the protein content of rice is much higher than that of potatoes (being on an average 8 per cent), carbohydrates make up the bulk of the total nutritive material, and, like potatoes, rice is properly classed as a carbohydrate food. If the value of a food is judged solely by its chemical composition, a wrong impression may be obtained. For instance, potatoes as purchased consist of one-fifth and rice of seven-eighths nutritive material. The first inference is that rice is more than four times as nutritious as potatoes. In one sense this is true, that is to say, a pound of uncooked rice contains more than four times as much nutritive material as a pound of raw potatoes. But if we take about 4 pounds of potatoes, that is, the amount necessary to furnish as much nutritive material as the pound of rice, the composition and nutritive value of the two quantities will be just about the same, while from a pecuniary standpoint the advantage would be on the side of the potatoes. The chief difference in the two foods before cooking is that one is juicy and bulky while the other is dry, and therefore more concentrated. In cooking rice we mix water with it, and may thus make a material not very different in composition from potatoes. By drying potatoes they can be made very similar in composition and food value to rice. Considering the two articles as ordinarily purchased, 4½ pounds of raw potatoes and a pound of uncooked rice contain nearly equal weights of each class of nutrients and have about the same nutritive value.

If a potato is grated and inclosed in a linen cloth and pressed, a large amount of juice will be obtained. The juice thus prepared is a dark-colored liquid which has an acid character, commonly said to be due to citric acid with more or less tartaric and succinic acids. The mineral matter present is very largely in the form of potash salts. The juice also contains some albuminoids (that portion of the total protein of most value as food), asparagin, and other organic compounds. If the grated potato is mixed with water, starch falls out from the broken cells and settles to the bottom of the vessel, and may be removed in the form of a white deposit. Starch is manufactured to a large extent from potatoes by methods which are similar to the above in principle.[1]

### THE COOKING OF POTATOES.

Although the potato owes its nutritive value principally to carbohydrates, it will be remembered that it contains some nitrogenous matter also. According to the investigations of Lawes and Gilbert, the juice of the potato contains more proteid or albuminoid nitrogen than the flesh. This is an important matter, since albuminoid nitrogen is more valuable for the body than nonalbuminoid nitrogen. In general, it may be said that 85 per cent of both protein and mineral matter

[1] For an extended account of the manufacture of starch from potatoes, see Bulletin No. 58, Division of Chemistry, U. S. Department of Agriculture.

in the potato (the latter being valuable for dietetic reasons, though not a nutrient) is in the juice. More or less of the juice of any food may be accidentally lost when it is prepared for the table; and the possibility of loss in cooking, due to this and other factors, is a matter of importance. Any sugar or other soluble carbohydrates might be removed if potatoes were cooked by boiling. No considerable loss of starch as such is to be expected, since starch is insoluble in water. Some starch is changed to a soluble body, dextrin, a sort of sugar, by the action of dry heat, possibly also when water is present.

The principal ways of cooking potatoes are baking, boiling, and frying, or some modifications of these processes. The objects sought are principally to soften the tissues and render them more susceptible to the action of the digestive juices and to improve the flavor. Just why cooking changes the flavor as it does has apparently never been made the subject of investigation. In potatoes, as in other foods, the cooked starch is more agreeable to the taste than the raw. Possibly also there

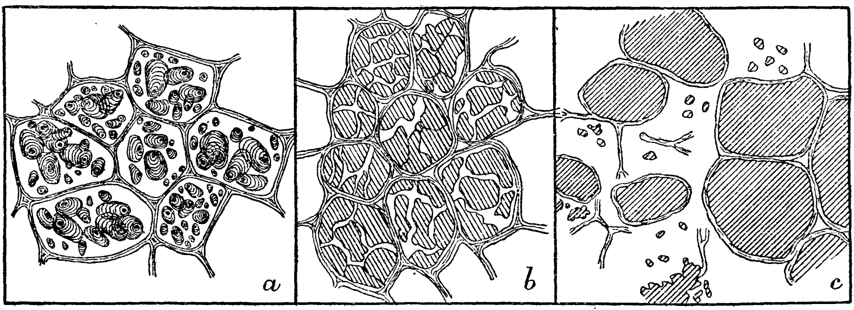


FIG. 45.—Changes of starch cells in cooking: *a*, cells of a raw potato with starch grains in natural condition; *b*, cells of a partially cooked potato; *c*, cells of a thoroughly boiled potato.

are volatile bodies of more or less pronounced flavor, which are removed or produced by the heat of cooking. The physical condition of the potato is much affected by heat. In the raw potato the separate starch grains are inclosed in cells with walls composed of crude fiber, a material resistant to digestive juices. If potatoes were eaten raw, the digestive juices would not reach the starch as easily unless the cell walls happened to be ruptured mechanically, as in mastication. Heat, however, expands the water present, ruptures the cells, and breaks up the starch, expanding the granules, which, when raw, consist of tightly-packed concentric layers, to a mass of much less solid structure. These changes are shown in fig. 45.

The albuminoids in foods are coagulated by heat, and so are rendered insoluble in water in which food is cooked. This explains why foods, meat especially, should be plunged into boiling water if it is desired to retain the albuminoids. The heat at once coagulates the albumen on the surface, thus preventing more or less completely the extraction of materials in the inner portion. It seems probable that this reasoning would apply to potatoes as well as to meat, although they contain much less albumen. The effects of cooking potatoes by boiling in different ways were tested not long ago at the Minnesota and the Connecticut (Storrs) Agricultural Experiment stations. The potatoes were boiled in distilled water, limewater, and alkaline water; part were boiled in water hot at the start and part in water cold at the start. In some cases the potatoes were peeled before boiling and in some cases this was not done. In two tests the peeled potatoes were soaked before boiling. The total loss of material (dry matter) ranged from 6.5 per cent of the total amount present in the case of the peeled potatoes soaked before boiling to 0.2 or 0.3 per cent in the case of the potatoes boiled with the skins on. The greatest loss of total nitrogen and ash was also found when the peeled potatoes were soaked before boiling; least when this was not done. Whatever the method of boiling, little of the carbohydrates was lost. From the experiments as a whole, it may be said that when potatoes are boiled with the skins removed there is a very considerable loss, not only of organic nutrients, but also of mineral salts. To obtain the highest food value, potatoes should not be peeled before cooking. When potatoes are peeled before cooking and placed directly in hot water and boiled rapidly, less loss of materials is sustained than when they are cooked in water cold at the start. If potatoes are peeled and soaked in cold water before boiling the loss of nutrients is quite considerable; in the case of proteids, being equal to one-fourth of the amount present. The loss in a bushel of potatoes thus cooked would be equivalent to the albumen in a pound of sirloin steak. When potatoes are boiled with the skins removed the greatest actual loss of nutrients seems to be due to the mechanical abrasion of some of the soft outer portions while cooking. In the experiments at the Connecticut (Storrs) Agricultural Experiment Station it was found that nearly 3 per cent of the carbohydrates and 4 per cent of the albuminoid material were lost when potatoes were thus cooked. When the potatoes were boiled with the skins on the loss of nutrients was very slight, consisting chiefly of nonalbuminoid nitrogenous substances and mineral matter. It is therefore evident, if it is desired to boil potatoes with as little loss as possible, that the skins should be left on.

Comparatively speaking, there are probably few cases in which it is necessary to take account of the losses due to different methods of boiling potatoes and where the possibility of loss would outweigh the liking for them prepared in some particular way, but in institutions where a large number must be provided for, and, in fact, under any condition where rigid economy is necessary, the matter may assume considerable importance.

An extended study of the relative composition of large, medium, and small potatoes, and of the different parts of the tubers and of the taste and culinary properties, was recently reported by Coudon and Boussard, two French scientists. The authors believe that the culinary value of potatoes is directly proportional to their nitrogen content and inversely proportional to their starch content. The different varieties of potatoes were found to vary greatly in their resistance to boiling, some retaining their form completely, while others were almost wholly disintegrated. The opinion was advanced that resistance to boiling depends principally upon the relative amount of albuminoids present. No definite relation was observed between chemical composition and early maturity. Generally speaking, the early varieties contained more water and nitrogenous materials and less starch than the late varieties tested.

As regards chemical composition, it may be said in general that boiled potatoes contain a little less water than raw potatoes, and except as this changes somewhat the proportion of nutrients, they differ little in composition from the raw. Mashed potatoes, if they are not seasoned, must necessarily have the composition of the unmashed boiled potato, making allowance for the small proportion of water which would probably be lost by evaporation in mashing. When milk, cream, or butter is added to mashed potatoes in preparing them for the table the nutritive value is increased, though the chief reason for adding such materials is doubtless to improve the flavor. This is also the reason why salt and pepper are added. Baked potatoes have practically the same composition as the uncooked, some water being lost by evaporation. When potatoes are fried, as in making potato chips, they lose by evaporation much of the water present and absorb more or less fat. They therefore have a higher nutritive value, pound for pound, than raw potatoes. Potato chips have been found by analysis to contain 2 per cent water and 39.8 per cent fat, as compared with 78 per cent water and 0.1 per cent fat when raw. The many ways of cooking potatoes, with or without the addition of other materials, which are described in books devoted to cookery, are in principle modifications of those already alluded to. The wholesomeness of potatoes cooked in different ways is largely a matter which each must decide for himself, the general experience being that for men in health most of the methods followed are satisfactory.

Evaporated potatoes are now on the market, being especially recommended for provisioning camps and expeditions. As compared with fresh, the evaporated potatoes have a high nutritive value in proportion to their bulk. This is the case with all evaporated foods, such material having been concentrated by the removal of a large proportion of the water originally present.

## DIGESTIBILITY OF POTATOES.

In considering the nutritive value of any food, the digestibility must be taken into account, for it is what the body can absorb from any given material as it passes through the digestive tract, rather than chemical composition, which determines food value. The digestibility of potatoes has been frequently studied. Some years ago Rubner kept a Bavarian soldier who was used to eating large quantities of potatoes on a potato diet for two days. The potatoes were boiled and eaten with salt or with vinegar and oil as a salad. The carbohydrates, the principal nutritive material in the potatoes, were quite thoroughly assimilated. As is usually the case, the digestibility was determined by deducting from the total nutrients present in the food the quantities excreted in the feces. The protein was not well digested. Similar results were obtained by a later German investigator, though in this case the protein was somewhat more thoroughly digested. In this experiment about three-fourths of the crude fiber present was found to be digestible. A number of experiments on the digestibility of potatoes were also made in St. Petersburg by a Russian investigator with three healthy men. Each test was divided into two periods. In one a simple mixed ration was eaten; in the other the food consisted of cooked potatoes only—baked, boiled, or fried in oil. It was found that 93 per cent of the total dry matter (which in the potato consists largely of starch) was digestible; of the total nitrogen present, 59 per cent; and of the albuminoid nitrogen, 41 per cent. In experiments on the digestibility of potatoes by man, recently made at the Minnesota Agricultural Experiment Station, it was found that 71.9 per cent of the protein and 93 per cent of the carbohydrates were digested or assimilated. In this experiment the potatoes were eaten with some eggs, milk, and cream, so the conditions may be assumed to be about normal. How far the digestibility of any food is influenced by the foods eaten with it is a matter on which little reliable information is available.

The experiments cited above show little, if anything, regarding the ease or rapidity of digestion, and, indeed, trustworthy data of this sort regarding any food are not abundant. According to some investigations made a number of years ago by Beaumont, and which have been frequently quoted, roasted or baked potatoes require somewhat less time than bread for digestion in the stomach (conversion into chyme); boiled potatoes require the same time as bread, namely, three and one-half hours. Too much importance should not be attached to these differences, as no account was taken of digestion in the intestines. As the digestion of starch takes place in the intestinal tract after the food has left the stomach, this is a matter of great importance in the case of starchy foods like the potato. The total length of time the potato remains in the body probably does not vary much with the different methods of cooking. Furthermore, if a person is in health it does not necessarily follow that there is any advantage in digesting one food more rapidly than another.

## FLAVOR OF POTATOES.

The flavor of potatoes depends chiefly on the substances which are dissolved in the juice. These include various mineral matters, citric acid, and other organic bodies in different combinations. It seems probable that the character of the soil and the amount of moisture it contains exert an influence upon the flavor, as the same varieties of potatoes grown under different conditions vary more or less in this respect. It has been found, for instance, that potatoes manured with muriate of potash yield watery tubers. That such causes may have a marked effect, is shown by the extreme case in which potatoes grown in very wet soil sometimes have small tubers above ground in the axils of the leaves instead of under the surface. Such tubers have an unpleasant flavor, and for this reason, if for no other, are unfit for food. The strong, unpleasant flavor of potatoes which have grown at the surface of the ground, and more or less exposed to the influence of light, is familiar. The green color of such potatoes is due to the chlorophyll formed under the influence of light. The unpleasant flavor is attributed to solanin. Potatoes which have been touched by the frost possess a sweetish flavor. According to analyses of normal and frozen potatoes, this is due to the conversion of some starch into sugar. Normal potatoes were found to contain from 13 to 16 per cent soluble material and from 84 to 87 per cent insoluble material, while the percentage of the former in the frozen potatoes ranged from 14 to 20 and of the latter from 80 to 86 per cent. In the normal potatoes starch constituted 67 to 76 per cent of the total insoluble material and sugar 0.3 to 0.7 per cent of the total soluble material. In the frozen potatoes only 58 to 72 per cent of the total insoluble material was starch, while the sugar amounted to from 0.4 to 1.7 per cent of the total soluble material. This change of starch into sugar is attributed to the action of a ferment present in potatoes. The explanation seems reasonable, since it is known that ferments play an important part in the chemical processes which take place in plants.

It is undoubtedly true that many persons select fruits and vegetables on the basis of size and appearance, large fruit or vegetables of fine color being given the preference without regard to their flavor. There are, however, many who realize that different varieties vary greatly in flavor, and are governed by this fact in their selections. Such discrimination has developed, for instance, a special market for certain finely flavored varieties of fruits. It is undoubtedly much less common for the purchaser of potatoes to be governed by flavor in his selection of them, and yet the different varieties, or the same variety grown under different conditions, vary greatly in this respect. A smooth potato of good form and size does not necessarily possess a flavor superior to one in which these characteristics are less marked, yet it would perhaps almost always be given the preference by most purchasers. Good flavor in potatoes is a matter worth attention. If purchasers demanded this quality as well as attractive appearance and size, growers would without doubt meet the demand.

### PLACE OF POTATOES IN THE DIET.

According to statistics obtained in the large number of dietary studies made in this country, potatoes constitute about 13.7 per cent of the total food consumed by the average American family, and furnish not far from 3.9 per cent of the total protein and 10 per cent of the total carbohydrates.

The potato is a staple article of diet in almost every household. The universality and extent of its consumption would seem sufficient to prove it to be a wholesome and nutritious food. The statement, however, is frequently met with in popular articles that potatoes are not wholesome. So far as can be learned this is purely a gratuitous assumption. While it is possible that there are persons with whom they do not agree, or who for some reason are compelled to forego starchy foods, there is no reason to suppose that potatoes are not as a rule a useful and wholesome article of diet.

The potato is essentially a starchy food, and eaten alone it would furnish a very one-sided, badly balanced diet, which would probably prove unwholesome to most people, as it has been estimated that man in health, performing a moderate amount of muscular work, is best maintained by a diet furnishing daily 0.25 pound protein in addition to fat and carbohydrates enough to make the total fuel value 3,500 calories, while a man without active physical labor might be well nourished with 0.20 pound of protein and 3,000 calories of energy. When the potato is eaten with meat, eggs, fish, etc., which are essentially nitrogenous foods, a well-balanced diet, which is most conducive to health and vigor, is secured.

Scientific investigation shows that the practice, which has become so general, of serving potatoes with meat and other similar foods which contain liberal amounts of protein is based upon correct principles, one food supplying the deficiencies of the other.

Potatoes and other foods containing carbohydrates are sometimes objected to on the ground that they are starchy foods and do not supply much nitrogenous material. It should be remembered, however, that the potato does contain a by no means inconsiderable amount of protein, and further that carbohydrates are an essential part of a well-regulated diet. The digestion experiments referred to above show that potatoes properly cooked furnish such material in a digestible form. They have been a staple article of diet for many years without harmful results, and therefore the conclusion that under ordinary circumstances they are other than a useful and wholesome food seems unwarranted.

### POSSIBLE DANGERS FROM EATING POTATOES.

Although under ordinary circumstances potatoes are unquestionably a wholesome food for most persons, illness is sometimes caused by eating them. There are undoubtedly some persons in health with whom potatoes do not agree, just as there are those who can not eat strawberries without distress. This is due to personal idiosyncrasy and not to the harmful character of the food. Reference can not be made here to the conditions of ill health in which potatoes or other starchy foods are forbidden, since this is a subject which pertains to the practice of medicine rather than the subject of dietetics. Cases of actual poisoning by potatoes are by no means unknown. So far as can be learned the abnormal symptoms in such cases were caused by the presence of solanin in the potatoes. Several years ago 357 soldiers in a battalion of the Austrian army showed symptoms of solanin poisoning. The potatoes used for food were examined. Those which were fresh contained a small amount of solanin, while those which had sprouted contained much more, still larger amounts being found in the sprouts than in the tubers themselves. The potatoes undoubtedly caused the poisoning in this case. Potatoes a year old which have lain in a cellar and shriveled and small potatoes which have sprouted without being planted are considered especially dangerous, and should not be eaten. If perfectly fresh potatoes contain any solanin, the amount is so small that it does not cause harm.

# THE SELECTION OF MATERIALS FOR MACADAM ROADS.

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## INTRODUCTION.

No one rock can be said to be a universally excellent road material. The climatic conditions vary so much in different localities, and the volume and character of traffic vary so much on different roads, that the properties necessary to meet all the requirements can be found in no one rock. If the best macadam road be desired, that material should be selected which best meets the conditions of the particular road for which it is intended.

The movement for better country roads which has received such an impetus from the bicycle organizations is still felt, and is gaining force from the rapid introduction of horseless vehicles. To this demand, which comes in a large measure from the urban population, is to be added that of the farmer, who is wakening to the fact that good roads greatly increase the profits from his farm produce, and thus materially better his condition; and to the farmer, indeed, we must look for any real improvement in our country roads.

In considering the comparative values of different rocks for road building, it must be taken for granted in all cases that the road is properly laid out, constructed, and maintained. For if this is not the case, only inferior results can be expected, no matter how good the material may be.

In most cases the selection of a material for road making is determined more by its cheapness and convenience of location than by any properties it may possess. But when we consider the number of roads all over our country which are bad from neglect and from obsolete methods of maintenance that would be much improved by the use of any rock, this regard for economy is not to be entirely deprecated. At the same time, as a careless selection leads to costly and inferior results, too much care can not be used in selecting the proper material when good roads are desired at the lowest cost. When macadam roads are first introduced into a district they are at worst so far superior to the old earth roads that the question is rarely asked, whether, if another material had been used, better roads would not have been obtained, and this at a smaller cost. When mistakes are made they are not generally discovered until much time and money have been expended on inferior roads. Such errors can in a great measure be avoided if reasonable care is taken in the selection of a suitable material. To select a material in a haphazard way, without considering the needs of the particular road on which it is to be used, is not unlike an ill person taking the nearest medicine at hand without reference to the nature of the malady or the properties of the drug. If a road is bad, the exact trouble must first be ascertained before the proper remedy can be applied. If the surface of a macadam road continues to be too muddy or dusty after the necessary drainage precautions have been followed, then the rock of which it is constructed lacks sufficient hardness or toughness to meet the traffic to which it is subjected. If, on the contrary, the fine binding material of the surface is carried off by wind and rain and is not replaced by the wear of the coarser fragments, the surface stones will soon loosen and allow water to make its way freely to the foundation and bring about the destruction of the road. Such conditions are brought about by an excess of hardness or toughness of the rock for the traffic. Under all conditions a rock of high cementing value is desirable; for, other things being equal, such a rock better resists the wear of traffic and the action of wind and rain. This subject, however, will be referred to again.

Until comparatively recent years but little was known of the relative values of the different varieties of rock as road material, and good results were obtained more by chance and general observation than through any special knowledge of the subject. These conditions, however, do not obtain at present, for the subject has received a great deal of careful study, and a fairly accurate estimate can be made of the fitness of a rock for any conditions of climate and traffic.

In road building the attempt should be made to get a perfectly smooth surface, not too hard, too slippery, or too noisy, and as free as possible from mud and dust, and these results are to be attained and maintained as cheaply as possible. Such results, however, can only be had by selecting the material and methods of construction best suited to the conditions.

In selecting a road material it is well to consider the agencies of destruction to roads that have to be met. Among the most important are the wearing action of wheels and horses' feet, frost, rain, and wind. To find materials that can best withstand these agencies under all conditions is the great problem that confronts the road builder.

## PHYSICAL PROPERTIES OF ROCK IMPORTANT IN ROAD BUILDING.

Before going further, it will be well to consider some of the physical properties of rock which are important in road building, for the value of a road material is dependent in a large measure on the degree to which it possesses these properties. There are many such properties that affect road building, but only three need be mentioned here. They are hardness, toughness, and cementing or binding power.

By hardness is meant the power possessed by a rock to resist the wearing action caused by the abrasion of wheels and horses' feet. Toughness, as understood by road builders, is the adhesion between the crystal and fine particles of a rock, which gives it power to resist fracture when subjected to the blows of traffic. This important property, while distinct from hardness, is yet intimately associated with it, and can in a measure make up for a deficiency in hardness. Hardness, for instance, would be the resistance offered by a rock to the grinding of an emery wheel; toughness, the resistance to fracture when struck with a hammer. Cementing or binding power, is the property possessed by the dust of a rock to act after wetting as a cement to the coarser fragments composing the road, binding them together and forming a smooth, impervious shell over the surface. Such a shell, formed by a rock of high cementing value, protects the underlying material from wear and acts as a cushion to the blows from horses' feet, and at the same time resists the waste of material caused by wind and rain, and preserves the foundation by shedding the surface water. Binding power is thus, probably, the most important property to be sought for in a road-building rock, as its presence is always necessary for the best results. The hardness and toughness of the binder surface more than of the rock itself represents the hardness and toughness of the road, for if the weight of traffic is sufficient to destroy the bond of cementation of the surface, the stones below are soon loosened and forced out of place. When there is an absence of binding material, which often occurs when the rock is too hard for the traffic to which it is subjected, the road soon loosens or ravels.

Experience shows that a rock possessing all three of the properties mentioned in a high degree does not under all conditions make a good road material; on the contrary, under certain conditions it may be altogether unsuitable. As an illustration of this, if a country road or city park way, where only a light traffic prevails, were built of a very hard and tough rock with a high cementing value, neither the best, nor, if a softer rock were available, would the cheapest results be obtained. Such a rock would so effectively resist the wear of a light traffic that the amount of fine dust worn off would be carried away by wind and rain faster than it would be supplied by wear. Consequently, the binder supplied by wear would be insufficient, and if not supplied from some other source the road would soon go to pieces. The first cost of such a rock would in most instances be greater than that of a softer one, and the necessary repairs resulting from its use would also be very expensive.

A very good illustration of this point is the first road built by the Massachusetts Highway Commission. This road is on the island of

Nantucket, and was subjected to a very light traffic. The commission desired to build the best possible road, and consequently ordered a very hard and tough trap rock from Salem, considered then to be the best macadam rock in the State. Delivered on the road this rock cost $3.50 per ton, the excessive price being due to the cost of transportation. The road was in every way properly constructed, and thoroughly rolled with a steam roller; but in spite of every precaution it soon began to ravel, and repeated rolling was only of temporary benefit, for the rock was too hard and tough for the traffic. Subsequently, when the road was resurfaced with limestone, which was much softer than the trap, it became excellent. Since then all roads built on the island have been constructed of native granite bowlders with good results, and at a much lower cost.

If, however, this hard and tough rock, which gave such poor results at Nantucket, were used on a road where the traffic was sufficient to wear off an ample supply of binder, very much better results would be obtained than if a rock lacking both hardness and toughness were used; for, in the latter case, the wear would be so great that ruts would be formed which would prevent rain water draining from the surface. The water thus collecting on the surface would soon make its way to the foundation and destroy the road. The dust in dry weather would also be excessive.

Only two examples of the misuse of a road material have been given, but, as they represent extreme conditions, it is easy to see the large number of intermediate mistakes that can be made, for there are few rocks even of the same variety that possess the same physical properties in a like degree. The climatic and physical conditions to which roads are subjected are equally varied. The excellence of a road material may, therefore, be said to depend entirely on the conditions which it is intended to meet.

It may be well to mention a few other properties of rock that bear on road building, though they will not be discussed here. There are some rocks, such as limestones, that are hygroscopic, or possess the power of absorbing moisture from the air, and in dry climates such rocks are distinctly valuable, as the cementation of rock dust is in a large measure dependent for its full development on the presence of water. The degree to which a rock absorbs water may also be important, for in cold climates this to some extent determines the liability of a rock to fracture by freezing. It is not so important, however, as the absorptive power of the road itself, for if a road holds much water the destruction wrought by frost is very great. This trouble is generally due to faulty construction rather than to the material. The density or weight of a rock is also considered of importance, as the heavier the rock the better it stays in place and the better it resists the action of wind and rain.

Only a few of the properties of rock important to road builders have been considered, but if these are borne in mind when a material is to be selected better results are sure to be obtained. In selecting a road material the conditions to which it is to be subjected should first be considered. These are principally the annual rainfall, the average winter temperature, the character of prevailing winds, the grades, and the volume and character of the traffic that is to pass over the road. The climatic conditions are readily obtained from the Weather Bureau, and a satisfactory record of the volume and character of the traffic can be made by any competent person living in view of the road.

### FRENCH METHOD OF MEASURING TRAFFIC.

In France the measuring of traffic has received a great deal of attention, and a census is kept for all the national highways. The traffic there is rated and reduced to units in the following manner: A horse hauling a public vehicle or cart loaded with produce or merchandise is considered as the unit of traffic. Each horse hauling an empty cart or private carriage counts as one-half unit; each horse, cow, or ox, unharnessed, and each saddle horse, one-fifth unit; each small animal (sheep, goat, or hog), one-thirtieth unit.

A record is made of the traffic every thirteenth day throughout the year, and an average taken to determine its mean amount. Some such general method of classifying traffic in units is desirable, as it permits the traffic of a road to be expressed in one number.

### IMPORTANCE OF RECORD OF TRAFFIC FOR PROPOSED ROADS.

Before this French method can be applied to the traffic of our country it will be necessary to modify considerably the mode of rating. This, however, is a matter which can be studied and properly adjusted by the Office of Public Road Inquiries. It is most important to obtain a record of the average number of horses and vehicles and kind of vehicles that pass over an earth road in a day before the macadam road is built. The small cost of such a record is trifling when compared with the cost of a macadam road (from $4,000 to $10,000 per mile for a 15-foot road), in view of the fact that an error in the selection of material may cost a much larger sum of money. After a record of the traffic is obtained, if the road is to be built of crushed rock for the first time, an allowance for an immediate increase in traffic amounting at least to 10 or 15 per cent had best be made, for the improved road generally brings traffic from adjoining roads.

### GROUPS OF TRAFFIC AND MATERIAL SUITED TO THEIR ACCOMMODATION.

To simplify the matter somewhat, the different classes of traffic to which roads are subjected may be divided into five groups, which may be called city, urban, suburban, highway, and country road traffic, respectively. City traffic is a traffic so great that no macadam road can withstand it, and is such as exists on the business streets of large cities. For such a traffic stone and wood blocks, asphalt, brick or some such materials are necessary. Urban traffic is such as exists on city streets which are not subjected to continuous heavy teaming, but which have to withstand very heavy wear, and need the hardest and toughest macadam rock. Suburban traffic is such as is common in the suburbs of a city and the main streets of country towns. Highway traffic is a traffic equal to that of the main country roads. Country-road traffic is a traffic equal to that of the less frequented country roads.

The city traffic will not be considered here. For an urban traffic, the hardest and toughest rock, or in other words, a rock of the highest wearing quality that can be found is best. For a suburban traffic the best rock would be one of high toughness but of less hardness than one for urban traffic. For highway traffic a rock of medium hardness and toughness is best. For country road traffic it is best to use a comparatively soft rock of medium toughness. In all cases high cementing value should be sought, and especially if the locality is very wet or windy.

Rocks belonging to the same species and having the same name, such as traps, granites, quartzites, etc., vary almost as much in different localities in their physical road-building properties as they do from rocks of distinct species. This variation is also true of the mineral composition of rocks of the same species, as well as in the size and arrangement of their crystals. It is impossible, therefore, to classify rocks for road building by simply giving their specific names. It can be said, however, that certain species of rock possess in common some road-building properties. For instance, the trap[1] rocks as a class are hard and tough and usually have binding power, and consequently stand heavy traffic well; and for this reason they are frequently spoken of as the best rocks for road building. This, however, is not always true, for numerous examples can be shown where trap rock having the above properties in the highest degree has failed to give good results on light traffic roads. The reason trap rock has gained so much favor with road builders is because a large majority of macadam roads in our country are built to stand an urban traffic, and the traps stand such a traffic better than any other single class of rocks. There are, however, other rocks that will stand an urban traffic perfectly well, and there are traps that are not sufficiently hard and tough for a

[1]This term is derived from the Swedish word trappa, meaning steps, and was originally applied to the crystallized basalts of the coast of Sweden, which much resemble steps in appearance. As now used by road builders, it embraces a large variety of igneous rocks, chiefly those of fine crystalline structure and of dark-blue, gray, and green colors. They are generally diabases, diorites, trachytes, and basalts.

suburban or highway traffic. The granites are generally brittle, and many of them do not bind well, but there are a great many which when used under proper conditions make excellent roads. The felsites are usually very hard and brittle, and many have excellent binding power, some varieties being suitable for the heaviest macadam traffic. Limestones generally bind well, are soft, and frequently hygroscopic. Quartzites are almost always very hard, brittle, and have very low binding power. The slates are usually soft, brittle, and lack binding power.

### METHODS OF DETERMINING VALUE OF ROCKS.

The above generalizations are of necessity vague, and for practical purposes are of little value, since rocks of the same variety occurring in different localities have very wide ranges of character. It consequently happens in many cases, particularly where there are a number of rocks to choose from, that the difficulty of making the best selection is great, and this difficulty is constantly increasing with the rapidly growing facilities of transportation and the increased range of choice which this permits. On account of their desirable road properties some rocks are now shipped several hundred miles for use.

There are but two ways in which the value of a rock as a road material can be accurately determined. One way, and beyond all doubt the surest, is to build sample roads of all the rocks available in a locality, to measure the traffic and wear to which they are subjected, and keep an accurate account of the cost both of construction and annual repairs for each. By this method actual results are obtained, but it has grave and obvious disadvantages. It is very costly (especially so when the results are negative), and it requires so great a lapse of time before results are obtained that it can not be considered a practical method when macadam roads are first being built in a locality. Further than this, results thus obtained are not applicable to other roads and materials. Such a method, while excellent in its results, can only be adopted by communities which can afford the necessary time and money, and is entirely inadequate for general use.

The other method is to make laboratory tests of the physical properties of available rocks in a locality, study the conditions obtaining on the particular road that is to be built, and then select the material that best suits the conditions. This method has the advantages of giving speedy results and of being inexpensive, and as far as the results of laboratory tests have been compared with the results of actual practice they have been found to agree.

### LABORATORY TESTS OF ROAD MATERIALS.

Laboratory tests on road materials were first adopted in France about thirty years ago, and their usefulness has been thoroughly established. The tests for rock there are to determine its degree of hardness, resistance to abrasion, and resistance to compression. In 1893 the Massachusetts Highway Commission established a laboratory at Harvard University for testing road materials. The French abrasion test was adopted, and tests for determining the cementing power and toughness of rock were added. Since then similar laboratories have been established at Johns Hopkins University, Columbia University, Wisconsin Geological Survey, Cornell University, and the University of California.

The Department of Agriculture has now established a road-material laboratory in the Division of Chemistry, where any person residing in the United States may have road materials tested free by applying for instructions to the Office of Public Road Inquiries. The laboratory is equipped with the apparatus necessary for carrying on such work, and the Department intends to carry on general investigations on roads. Part of the general plan will be to make tests on actual roads for the purpose of comparing the results with those obtained in the laboratory.

Besides testing road materials for the public, blank forms for recording traffic will be supplied by the Department to any one intending to build a road. When these forms are filled and returned to the laboratory, together with the samples of materials available for building the road, the traffic of the road will be rated in its proper group, as described above; each property of the materials will be tested and similarly rated according to its degree, the climatic conditions will be considered, and expert advice given as to the proper choice to be made.

# PRACTICAL FORESTRY IN THE SOUTHERN APPALACHIANS.

By Overton W. Price,
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## INTRODUCTION.

The Southern Appalachians offer an excellent field for practical forestry. The need of systematic and conservative forest management is beginning to be keenly felt, both for the timber tract and the wood lot. The present desultory form of lumbering, which dates from the settlement of the region, has resulted in a serious reduction of the existing supply of timber. The unnecessary damage which has accompanied this lumbering, together with the repeated fires and excessive grazing to which the forest has been largely subjected, has greatly retarded the production of a second crop. Although there is still enough wood to fill the wants of the settlers, the cost of obtaining it is constantly increasing with the growing distance between the supply and the market. Around the towns and villages the belt of woodlands from which all merchantable timber has been culled widens every year, while fire and grazing often prevent young trees from springing up on the cut-over area.

The rapid increase now going on in the values of timber and in the cost of firewood is premature in so densely forested a country, and is the direct result of wasteful methods in the utilization of its resources. A continuance of these methods will necessarily result in a serious check to the general prosperity of western North Carolina and eastern Tennessee, where the inhabitants have already to contend with the remoteness and ruggedness of the region, and with an exceedingly low percentage of arable land. These methods will, moreover, not only render it costly to obtain wood for home consumption, but will entirely destroy what is still the most important source of revenue in the Southern Appalachians—the lumbering of its valuable hardwoods to supply a steady and increasing demand in distant markets.

It is intended in this paper merely to outline the nature of the problem at hand and to suggest certain general lines of treatment that might be followed.

## GENERAL DESCRIPTION OF THE REGION.

The mountain region of western North Carolina and eastern Tennessee comprises an area of 15,000 square miles. It includes the Blue

Ridge on the east and the Smoky Mountains on the west, with the high and broken plateau which lies between them. Many spurs and ridges run off at right angles from these two ranges upon the plateau, and make of it the loftiest and most rugged section east of the Rocky Mountains. The more important of these cross chains are the Black Mountains, a spur of the Blue Ridge, which contain Mitchell Peak, 6,711 feet high; the Balsam Mountains, with a mean elevation of over 5,000 feet; and the Cowee Mountains, one of the longest of the cross ranges. Beginning on the east with the spurs of the Blue Ridge, which lose themselves in the Piedmont district, the elevation increases and the character of the mountain region grows more rugged westward toward the Smokies, in which the Appalachian system culminates.

The slates, granite, and gneiss, with their intermediate forms, are the chief underlying rocks. Of these, the gneiss is most common. It is usually soft, and disintegrates rapidly, forming a sandy loam which, although not particularly rich, is loose, fresh, and of great depth, except where the grade is such as to cause excessive erosion.

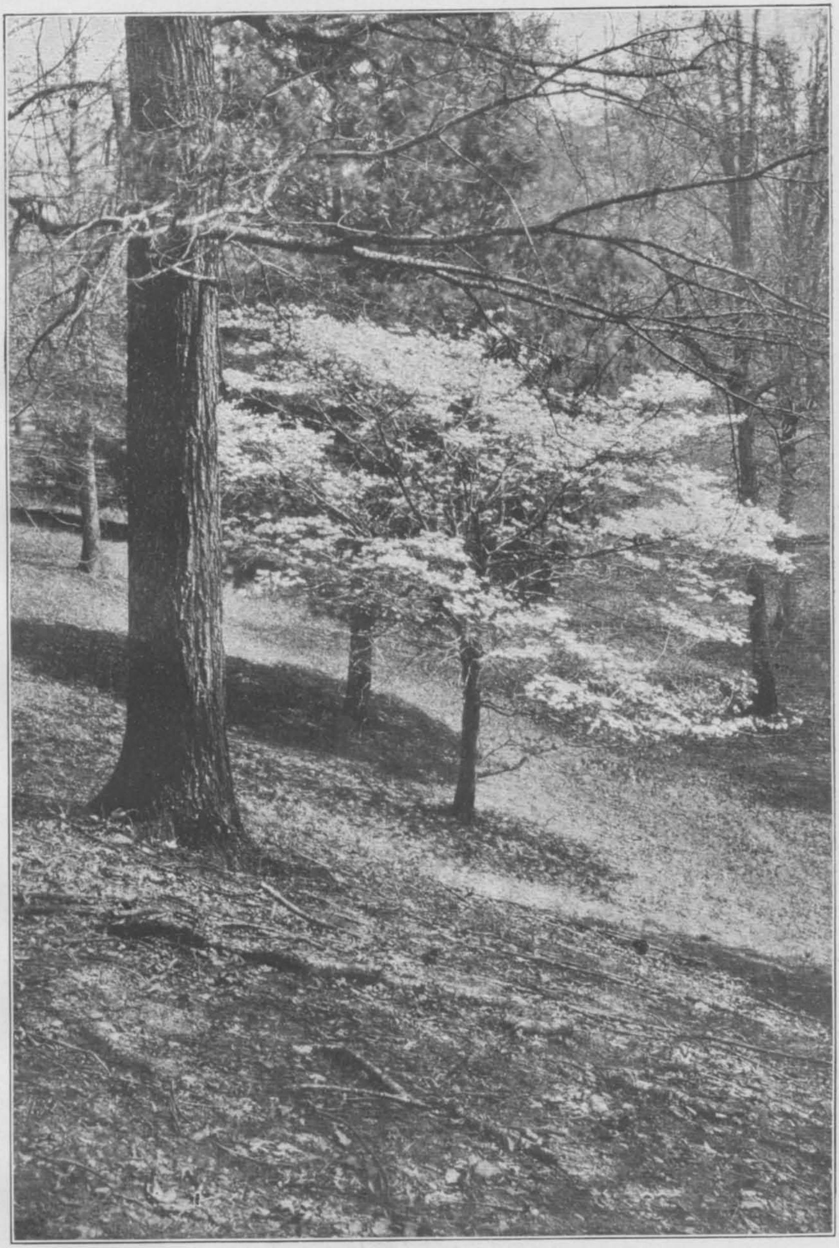
Where gneiss is the surface formation the slopes are generally smooth and rounded as a result of its rapid weathering. Where the slowly disintegrating granite forms the outcrop the topography is rugged and the slopes steep and bowlder-strewn, and sometimes craggy and precipitous, particularly those which face toward the south.

With the exception of the natural meadows which occupy the summits of some of the higher peaks, the mountains are covered with forest growth. The valleys are almost entirely under cultivation. Upland farming is carried on upon the foothills, and occasionally, for lack of better ground, upon mountain slopes so steep that their thorough cultivation is impossible.

## THE FOREST.

It has often been said that it is in this region that the forest trees of the North mingle with those of the South, and the statement gives but an incomplete idea of the great variety of trees which is here the result of wide local differences in soil and climate. Western North Carolina and eastern Tennessee contain over one hundred kinds of native trees. Of these, some, such as the Black Spruce and Balsam, which find in the Smokies at an elevation of 4,000 feet and over conditions similar to those of their northern habitat, are either too rare or too difficult of access to be often of commercial importance. Others, such as the Black Gum, Sourwood, Dogwood, Buckeye, and Aspen, are valueless for timber, and are used for firewood only when no better kinds are to be had. (Pl. XXXVIII.) Others again, among which are the Striped Maple, the Haw, and the Silverbell Tree, have as yet no merchantable value.

Among the commercial trees the more important hardwoods are the Yellow Poplar, the Oaks, Hickories, Chestnut, Birch, Ash, Cherry,



DOGWOOD IN FLOWER.

YELLOW POPLAR AND HEMLOCK ON NORTH SLOPE.

[Photograph by H. B. Ayres.]

Basswood, Black Walnut, and Maple. The merchantable softwoods, of which there are comparatively few, are chiefly Shortleaf Pine, White Pine, and Hemlock. They seldom predominate in the mixture, but occur by groups and single trees, the Shortleaf Pine in the larger valleys and on the foothills, the White Pine confined chiefly to coves and intermediate low ridges in the Blue Ridge, and the Hemlock along the streams and on the lower slopes of the mountain valleys. The latter, although much less common than farther north in the mountains of Virginia and West Virginia, on account of the increased number of faster-growing trees with which it has to contend, probably reaches in this region a larger size than anywhere else within its habitat.

### FOREST TYPES.

The many kinds of trees native to this portion of the Southern Appalachians, and the fact that most of them have a wide local range, renders the forest exceedingly varied and makes it difficult to classify it into types except in a very broad and general way. The Oaks, among which the White Oak is most frequent, form the chief part of the forest growth up to an elevation of about 2,500 feet. With them are mixed the Shortleaf Pine, the Hickories, and a host of subordinate kinds, among which the Black Gum and Red Maple are most common in moist situations, the Basswood, Birches, Ashes, Yellow Poplar, and Cucumber Tree on fresh soils, and the Chestnut, Locust, Dogwood, and Sourwood on south slopes and in dry localities generally.

At an elevation of 2,500 to 3,500 feet the number of the Oaks decreases and Yellow Poplar, Hemlock, Birch, Beech, Ash, Black Walnut, and Cherry reach their best development and predominate especially in coves and hollows with a northerly aspect. (Pl. XXXIX.)

Above 3,500 feet the forest falls off both in the number of different kinds of trees and in their size and quality. The Chestnut, Chestnut Oak, and Red Oak are the characteristic trees of this belt and occur almost pure on dry, steep slopes and ridges. Finally, at about 4,000 feet, dense woods of Black Spruce and Balsam Fir cover the ground to the exclusion of all other trees and reach to the mountain tops, except on the "balds," the local term for those mountains, the crests of which are occupied by natural meadows.

The general type of these forests, except where modified by lumbering or fire, or by both, is that of the virgin forest, exceedingly irregular in age and density. On the lower slopes, where the Oak prevails and where logging for timber and firewood has long been carried on, and which also have suffered from excessive grazing and repeated fires, the forest consists largely of second growth, seldom over forty years old. Above this second growth, in which a constant struggle goes on between the Oaks and the Shortleaf Pine, the latter holding its own almost everywhere and having the upper hand on the poor soils, stand mostly old oak and pine, which generally owe their presence to the fact that they are unfit for lumber. The result is a very irregular two-storied forest, the old oak and pine forming the upper story and the second growth the lower, the latter varying greatly in age in different localities, according to the dates of the lumbering, and often in the same locality, where there have been repeated cuttings, each one of which has induced a new growth of seedlings and stump shoots.

Higher up in the mountains, where there has been less fire and lumbering, is perhaps the most perfect form of the mixed virgin forest to be found in this country. Trees of all ages occur together, and there is seldom, except where a space has been laid bare by wind and seeded up, any approach to an even-aged growth. It is here that the struggle for existence has been carried on without intervention and that trees of each kind have held their own in the mixture through the characteristics which have been given them for that purpose—one by plentiful crops of seed, another by capacity to endure great shade, another by its rapid growth or its adaptability to many different soils and situations. The result has been a forest containing a wonderful variety of types and forms of mixture. Some of the trees, particularly the Yellow Poplar and Hemlock, show a marked tendency to distribution by groups and patches. The Ash, Basswood, Beech, and most of the others, however, are distributed evenly throughout those localities which are favorable to them.

This region shows a variety in the undergrowth which corresponds to the richness of its silva. Among the most characteristic shrubs and those which influence chiefly the reproduction of the forest are the Rhododendron and Kalmia, or Mountain Laurel, which in the higher mountains not infrequently form a distinct and almost impenetrable second story under the forest trees. After these the more important of the shrubs and shrub-like trees are the Serviceberry, Sumach, Magnolia, Holly, Sassafras, Haw, Stagbush, and Hazel.

### LUMBERING.

There are two distinct types of lumbering in the Southern Appalachians, similar in the extent of the harm done to the forest, but differing widely in the manner in which they are carried out.

The one is the slipshod, desultory form which has been practiced by the farmers of this region since its settlement in order to eke out the generally scanty profits from their farms. Although their output is small individually, their combined efforts, extending over many years, have resulted in the culling of the best timber over a large portion of the more accessible forests. The scattered distribution of the merchantable trees, however, has rendered the lumbering comparatively light except where firewood has been cut as well as saw logs.

The other dates from the time when, some fifteen years ago, with the failing supply of timber in Maine, Michigan, and the north woods generally, began the exodus of many Northern lumbermen to the hardwood forests of the Virginias, Georgia, and Tennessee, and to the pineries and cypress swamps in the far South. With their arrival began lumbering on a large scale in the Southern Appalachians, together with the investment of commensurate capital in logging outfits, the thorough repair and extension of logging roads, and the application of those skillful and businesslike methods which constitute clean lumbering. The active and systematic manner in which these men conducted a lumber job and the margin of profit which they wrung from it were a revelation to the natives, but have not yet resulted in any appreciable improvement in their methods.

It is nevertheless to be remembered that several factors have tended to make a poor lumberman of the farmer of western North Carolina or eastern Tennessee. He is often hampered by lack of the capital necessary to make the most of lumbering in this region, and he is generally wanting in the knowledge requisite to the best use of it. He has had always to contend with the difficulty of obtaining expert loggers to carry out the work, and is generally obliged, through the scarcity of available white men, to employ negroes, who seldom do well in the lumber woods, for the reason that they are usually strongly averse to the mode of life required of them. Nevertheless, the nearness of large bodies of merchantable timber, among which are valuable kinds, such as the Cherry, Black Walnut, Hickory, and Yellow Poplar, has usually made a fair profit possible under even the most thriftless logging methods.

The unnecessary damage to the forest and the total lack of provision for a future crop, characteristic of lumbering generally in the Southern Appalachians, is deplorable. It is a form of waste, however, which can not be eliminated by criticism, but can best be checked by proof of the advantages of more conservative methods, through their application to a portion of these forests, either by the Government upon its own lands or in cooperation with private owners.

There is, however, much immediate loss incurred by a species of slovenliness which is as foreign to clean lumbering as it is to practical forestry, and is entirely without excuse. Entire trees found to be unsound at the base are often left upon the ground to rot, rather than butt off the decayed portion. Not infrequently sound trees of a merchantable diameter are carelessly left uncut upon the lumbered area. There is great waste in high stumps and in lack of judgment in sawing up the trees, while careless felling leaves many a lodged tree in the woods or smashes the more brittle kinds, particularly the Yellow Poplar.

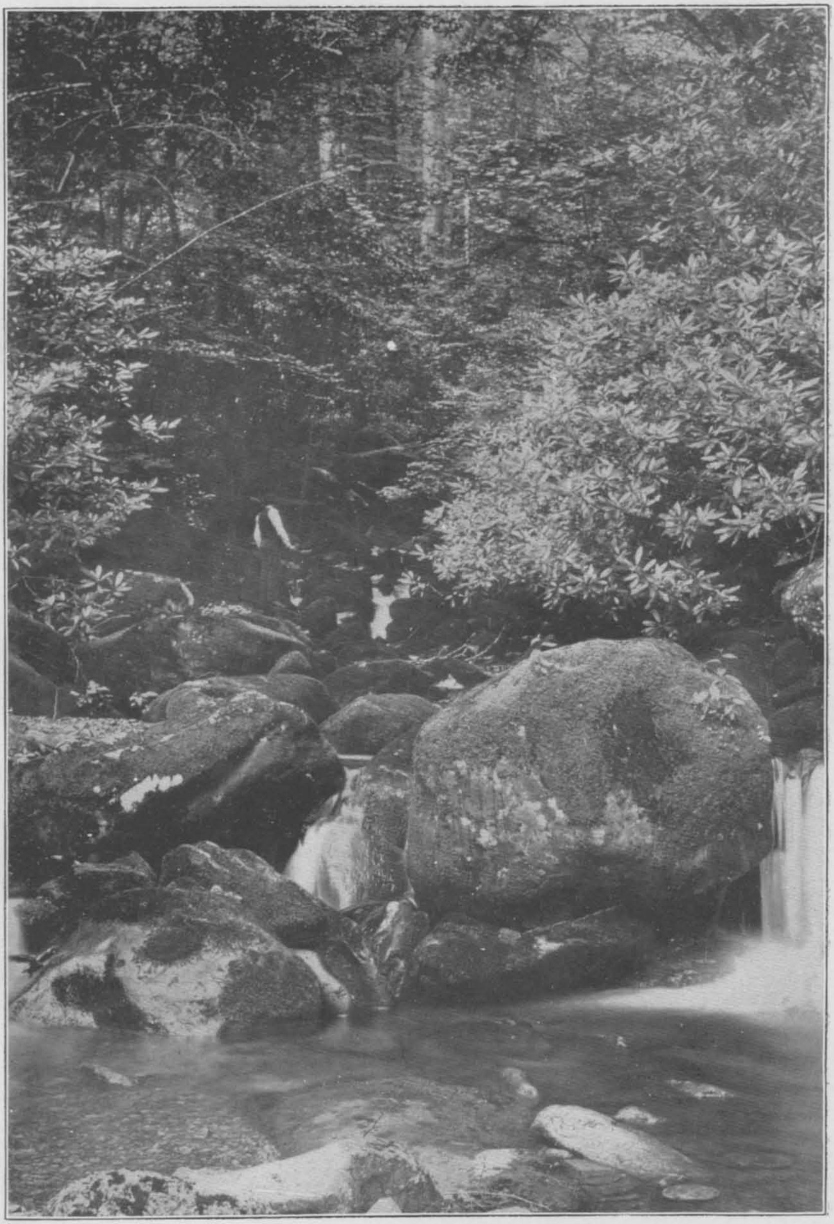
### THE LOCAL SYSTEM.

The local system of lumbering is exceedingly simple. The trees are felled and sawn into logs where they lie, and these are snaked, or skidded, by horses, or, more often, by cattle, to the roadside or the river bank. Logging streams are rare, however, in the Southern Appalachians, and the customary way of getting the logs to the mill or to the railroad is by wagon over the rough mountain roads. (Pls. XL and XLI.) It is a somewhat primitive system throughout, but it is the one most generally suited to the nature of the country and to the distribution of the merchantable timber, which does not often favor the employment of those labor-saving devices which have been found profitable in logging elsewhere. The lack of sufficient snow usually prevents the use of sleds instead of logging wagons. The topography is often better adapted to timber slides or to donkey engines and wire cables for bringing the logs to the roads than to snaking with teams. The merchantable timber, however, is generally so scattered that the amount which could be transported by one slide or from one spot by an engine and cable is seldom sufficient to render them profitable. These and similar appliances suitable to a rough mountain country, but to the success of which a dense merchantable stand, or, in other words, a large amount of timber upon a small area, is necessary, have here usually been found impracticable.

### DAMAGE TO THE FOREST.

The harm done to the forest is very great in proportion to the quantity of timber cut. This is due largely to the size of the trees and to the fact that little care is taken in the fellings. The damage to young growth is aggravated by the absence of snow and by the fact that the fellings are not infrequently made when the trees are in full leaf.

The breaking down and wounding of seedlings and young trees by the snaking of the logs to the roadside or the river is in large part unavoidable. There are often, however, many more snakeways, or skidways, than are necessary, and the application of a little system in laying them out would save time and young growth on a lumber job. On the higher and steeper slopes it is often the habit, and one which can not be criticised too strongly, except in those rare cases where it is absolutely necessary on account of the gradient, to roll the logs from top to bottom, merely starting them with the cant hook. A 16-foot log, 3 feet or more in diameter, can gain momentum enough in this way to smash even fair-sized trees in its path, and should it pass through dense young growth it leaves a track like that of a miniature tornado. The practice is in line with others to be observed in the Southern Appalachians, such as the common habit, for example, of leaving to rot the "deadened" trees which stand over clearings.



A CHARACTERISTIC MOUNTAIN STREAM.

[Photograph by H. B. Ayres.]

A MOUNTAIN ROAD.

[Photograph by H. B. Ayres.]

A DEADENING.

[Photograph by H. B. Ayres.]

There are cases in which these clearings have been inclosed with fences built of rails split from prime Black Walnut, with no other excuse than that the walnut happened to be within easier reach than either Oak or Pine. (Pl. XLII.)

Under such methods, in which there is not only an absolute lack of provision for a future crop, but often a marked absence of that forethought, skill, and aversion to waste which go to make clean lumbering, most of the logged-over areas in the Southern Appalachians are only saved from entire destruction of the standing trees by the generally scattered distribution of the merchantable timber.

### FIRE.

Fire has done, and continues to do, enormous damage in the Southern Appalachians. This has been the result not only of local conditions, which are exceedingly favorable to fires, but of a very passive sentiment in regard to them. In most great forest regions, with increase in population has grown a more determined attitude toward forest fires and a consequent falling off in the frequency of their occurrence. This has not yet been the case in the Southern Appalachians. The area burned over annually has increased rather than diminished, and the general feeling among the natives is one of somewhat placid resignation to an evil which is not fully realized and which is considered almost inevitable. Inevitable it assuredly is not; but there are several factors which combine to render fires in this region exceedingly difficult to check when once they are started. The absence of snow except for short periods, or of a marked rainy season, makes the danger a generally constant one throughout the time when the trees are leafless. There are seldom in the higher mountains any clearings or natural openings to serve as fire breaks, and the forests contain a large amount of dead timber, which adds power to the fires.

#### CAUSES OF FIRES.

There is not enough game in the Southern Appalachians to encourage camping during the autumn and winter months, and very few of the forest fires can be laid to campers. The number set maliciously is also small. Some are undoubtedly started each year by carelessness in the lumber camps, from the burning of tops and branches in the recent clearings, or by tourists and cattlemen. By far the larger number, however, are the result of the long-established practice of burning over the woods in the autumn under the belief that better pasturage is thus obtained the following year. These fires are set by the farmers on the area upon which they expect to turn out their sheep and cattle during the next season, and there is rarely an attempt made to confine them unless a neighbor's house or barn should be endangered. The consequence is that, except when isolated by roads or clearings, they often spread from the wood lots of the valleys and foothills in which they are set out to the forests of the higher mountains, where they burn unmolested for days or even weeks, until finally extinguished by rain, snow, contrary wind, or lack of inflammable material in the sparse forests of the stony upper slopes. These fires are set year after year upon the same areas. They decrease annually in heat and power on the areas already burned over, until finally, with almost every vestige of the humus destroyed and the mineral soil baked and hardened, there is but little left upon the ground to burn except the leaf-fall of the preceding season.

It would seem that so common and ancient a practice as the burning over of forest land in the Southern Appalachians in order to improve the pasturage would long since have been abandoned had it not proved successful. However, apart from the damage caused to the forest, doubt has already arisen among some of the farmers themselves as to whether it is not, after all, a short-sighted policy. The result of burning over forest land the first time in this region is undeniably to destroy shrubs and seedlings and to stimulate the growth of weeds and grasses which afford good grazing. On the other hand, there are many localities which owe their unfitness for grazing to repeated fires. The final result is a sparse, unhealthy forest, entirely insufficient to protect from sun and wind the hardened and impoverished soil beneath it, which is generally covered with a straggling growth of broom sedge or wire grass, and is practically bare of other herbage. On slopes, where the admission of light and the destruction of the vegetable mold has been followed by more or less excessive erosion, the mineral soil is sometimes exposed, or even worn down to the underlying rock, where it is near the surface.

The whole matter awaits thorough and systematic study before it can be authoritatively stated whether, disregarding the damage to the timber and with a view to grazing only, it is best to exclude fire entirely from forest land in this region or under what conditions and restrictions to make use of it. The local grazing interests are important, and the annual fires will continue until it has been established to the satisfaction of the natives that they fail of their prime object in the long run. A detailed investigation on the ground of this matter by unprejudiced men, with the publication of its results, will be the first and most important step toward the protection of these forests from fire.

### DAMAGE BY FIRES.

The immediate damage done by fire in the Southern Appalachians is much slighter than in the evergreen forests of the North and West. Crown fires are rare except in particularly dry seasons and under a high wind, and it is seldom that trees are consumed or even killed outright, except in second growth and young woods. The chief harm done is in the killing of young tree growth and in the decay which starts from the scars left at the base of the trees, to which the Yellow Poplar, the White Oak, and the Hickories are particularly susceptible. The first thing for the timber cruiser here, after he has satisfied himself of the size and quality of the merchantable stand, is to look for traces of severe fires. Should they have run over the area, it is possible that the labor and loss in timber of butting off the decayed portion at the base of the tree may seriously impair the profit from the lumbering.

Apart from damage to the merchantable stand, the result of fire is here also greatly to disturb the balance between the different trees, a matter of some importance where there is so large a number in mixture, many of which are practically worthless. For example, the Dogwood, Sourwood, Black Jack, and Scrub Oak offer great resistance to fire, and are characteristic kinds in the young growth on burned-over lands. Repeated fires on White Oak and Poplar land will soon so dry out and impoverish the soil as to render it unfit for the reproduction of those species, to which a moist, rich soil is necessary. On the foothills and in the larger valleys where the Shortleaf Pine enters prominently into the mixture, oak forests are constantly being converted into pine forests through the agency of fire. A dense growth of Kalmia is frequently the result of repeated fires on south slopes and renders the growth of the seedlings difficult or even impossible.

## SUGGESTIONS FOR MANAGEMENT.

There are two problems presented to practical forestry in the Southern Appalachians: The one, the management of the cut-over lands of the foothills and larger valleys, which have suffered from excessive grazing and repeated fires, and have been lumbered heavily, not only for timber, but also for fuel; the other, the management of the forests of the higher mountains, which still contain large bodies of virgin timber, and in which fire and grazing have done comparatively little damage. These are the two great classes of forest land in this region. They differ not only in past treatment and in the character, quality, and amount of the stand, but also in the demands which are made upon them. The forests of the foothills and lower valleys constitute the wood lots which must supply the farmer with his firewood and fencing. The mountain forests, on the other hand, are usually so difficult of access that they are as yet of value only for saw logs.

### CUT-OVER LANDS.

It has already been mentioned that the cut-over lands characteristic of the more accessible and thickly populated districts consist largely of uneven-aged second growth, chiefly of Oak and Pine, with scattered old trees of the same kinds standing above it. The density is generally low and the quality of the old trees exceedingly poor, while the second growth is often characterized by the presence of worthless species, by injuries due to fire and grazing, and by a lack of vigor which is the result of excessive shade. In some localities, where the young trees have been killed off by fire and there is left only a scanty remnant of the old stand, cuttings can do no good, and would be likely still further to impair the meager chances for successful reproduction. The larger part of these forests, however, is in urgent need of improvement cuttings, with the object of producing a denser and healthier growth, and of removing the trees of worthless kinds which have sprung up after lumbering or form a part of the old stand. The cutting out of undesirable species, such as Dogwood, Sourwood, and Scrub Oak, of branchy advance growth which is suppressing promising seedlings and saplings, and the gradual removal of the old trees, would be in line with this policy. These cuttings would entail no more than a thorough understanding of their purpose and a reasonable amount of care in their execution. They could be carried out successfully by the farmers after the principles had once been illustrated and explained by a forester. Their entire practicability has been forcibly illustrated upon the Biltmore estate, near Asheville, N. C., where about 4,000 acres of woodland, formerly owned by a number of small farmers, are made to produce annually about 3,000 cords of firewood, with a steady and marked improvement in the general condition of the forest.

It is often urged by the farmers that these careful cuttings would cost more than would be brought by the sale of their produce. The Biltmore experiment, in which a rule has been made that all cuttings shall at least be self-supporting, has satisfactorily established the fallacy of such a view. The firewood cut upon the Biltmore estate is sold in the open market in competition with that taken by the farmers from their own lands and under their own methods, and it realizes a fair margin of profit above the cost of cutting and hauling. It is to be remembered, however, that the good results of these improvement cuttings in the forests of the Biltmore estate would have been seriously impaired had not cattle and fire been kept out since the institution of systematic and conservative management.

### VIRGIN FORESTS.

The mountain forests of the Southern Appalachians are silviculturally the most complex in the United States. They contain many kinds of trees varying widely in habit and also in merchantable value, and the forest type is constantly changing with differences in elevation, exposure, gradient, and soil. Their proper management is difficult, because the lack of uniformity in the forest renders it necessary constantly to vary the severity of the cuttings and to discriminate in the kinds of trees which are cut, instead of following only those general rules which suffice where there are fewer species represented and the forest conforms more closely to a single type. In order to reproduce these forests successfully and to minimize the damage done by lumbering, first of all it will be necessary to have a radical improvement in the fellings. Such an improvement is entirely practicable, without additional cost per 1,000 feet B. M. of timber felled. It often requires no more labor to fell a tree up a slope than down it, or upon an open space rather than into a clump of young growth; and it is in just such cases as these that unreasoning disregard for the future of the forest is commonly manifested in the Southern Appalachians.

In the selection of trees to be felled, the small farmers, who for a long time were the only lumbermen in the Southern Appalachians, have been governed by the same considerations which govern lumbermen elsewhere. They have taken the best trees and left uncut those of doubtful value rather than run the risk of loss in felling them. Furthermore, the fact that they have lumbered generally on a very small scale and have often had great difficulties with which to contend in the transport of logs has led them to extremes in this respect. The result is that they have reduced the general quality of their forests in a measure entirely disproportionate to the amount of timber cut. As a rule, only prime trees have been taken, and those showing even slight unsoundness left uncut, except where the stand of first-class timber was insufficient. Diseased and deteriorating trees remain, to offset the growth of the forest by their decay and to reduce its productive capacity still further by suppressing the younger trees beneath them, while in the blanks made by the lumbering worthless species often contend with young growth of the valuable kinds. In other words, the lumbering has closely followed the selection system, but the principles governing the selection have usually been at variance with the needs of the forest.

In order to bring about successful reproduction of the desirable species and to maintain the quality and density of the stand, lumbering in the mountain forests of the Southern Appalachians must be governed by the following main considerations:

(1) Remove all diseased, overripe, or otherwise faulty trees of a merchantable size where there is already sufficient young growth upon the ground to protect the soil and to serve as a basis for a second crop of timber. In extreme cases, where the condition of the forest is greatly impaired by the presence of a large number of such trees, or where they overshadow and seriously retard promising young growth, their removal may be financially advisable when the sale of the produce no more than pays the cost of logging.

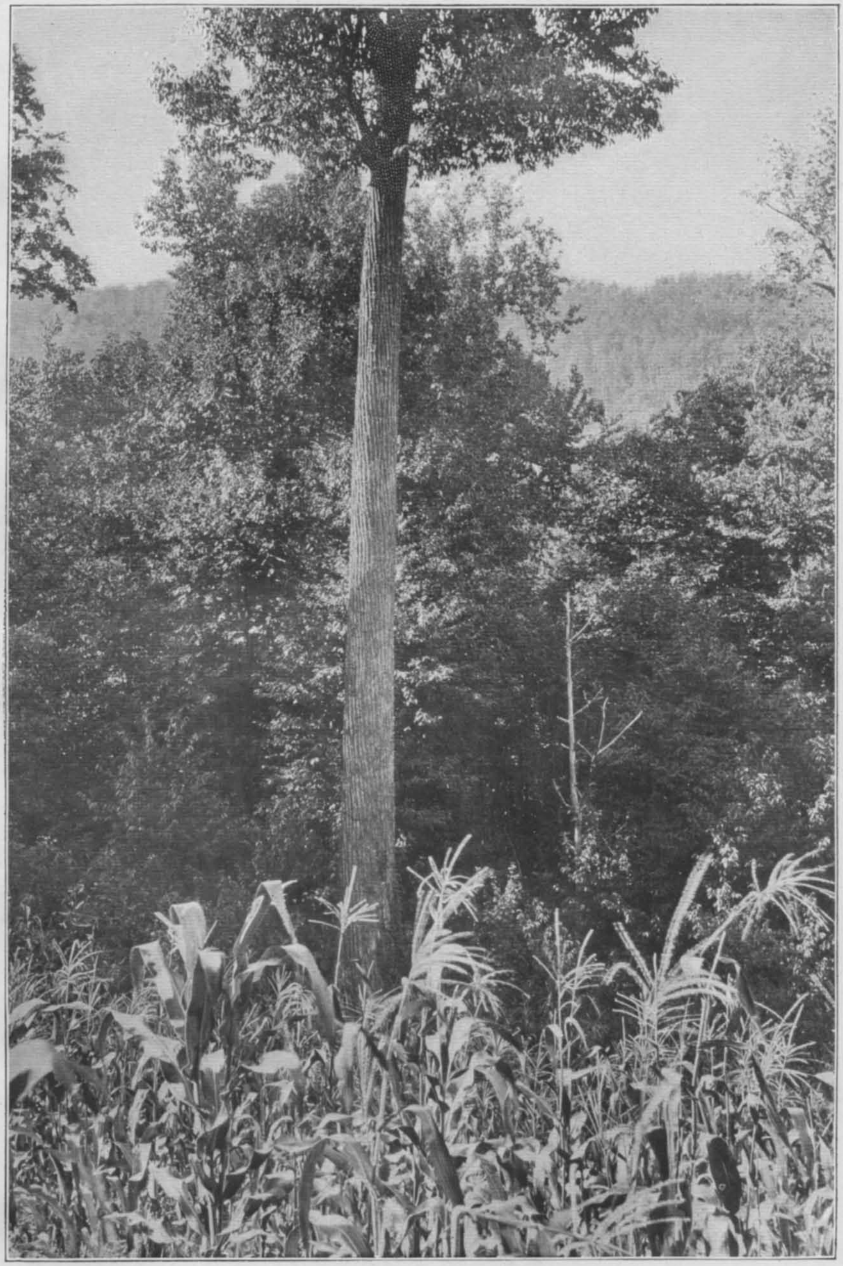
(2) So direct the cuttings that the reproduction of the timber trees may be encouraged in opposition to that of the less valuable kinds. This can not be successfully accomplished in the Southern Appalachians

by cutting to a diameter limit merely. A limit will by all means be advisable for each species, based upon a study of its rate of growth and the proportion which different diameters bear to its contents in board feet. It will be frequently necessary, however, to leave trees of a merchantable diameter where their removal would seriously impair density or where seed trees are necessary. In the leaving of seed trees many considerations are involved, only a few of which can be mentioned here. The Oaks, Hickories, Walnut, and Chestnut should be favored, since their seed is too heavy to be carried by wind, and much of it is eaten by animals. (Pl. XLIII.) The marked tendency of the Hemlock and Yellow Poplar to reproduce by groups must be encouraged. On south slopes and in dry localities generally, where Dogwood, Sourwood, and Scrub Oak contend with the timber trees, great care must be taken not to disturb the balance between them. The rich, moist soil of the poplar coves is particularly likely to produce a luxuriant growth of weeds and brambles instead of tree seedlings if too much light is admitted to the soil; while the Ash, Cherry, and Basswood, which are only sparsely represented in the mature stand and are further handicapped among the young growth by their strong demands upon light, would require an exceedingly conservative method of management.

### NEED OF PRACTICAL FORESTRY.

The degree of care which is justified in the lumbering of any forest depends primarily upon the value of the timber which it produces. The higher the margin of profit on lumbering the larger the capital which is represented by the immature trees and the more important the financial considerations involved in their protection. Stumpage values are not sufficiently good in the Southern Appalachians to warrant the application of an elaborate system of forest management, but they are high enough to make a sound business measure of practical forestry. The production of repeated crops of merchantable timber is here advisable, not only on account of the price this timber commands at present, but because it is rapidly increasing in value for the lack of satisfactory substitutes, notably in the case of the Black Walnut, Cherry, Hickory, White Oak, and Yellow Poplar.

From the point of view of the State, further considerations are involved in the preservation of the forests of this region. They constitute the drainage basins of several important rivers, there is no other great forest region except the Adirondacks of northern New York which is within easy reach of so large a number of people, and its healthfulness is sufficient to have transformed it in the last twenty years from what was practically a wilderness to a deservedly popular health resort.



THE CHESTNUT.
[Photograph by H. B. Ayres.]

# COMMERCIAL PEAR CULTURE.

By M. B. Waite,

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## BOTANICAL CLASSIFICATION.

From the standpoint of the botanist, the pears which are cultivated in America for their fruits may be divided into two groups: (1) The European group, originating from *Pyrus communis*, the native pear of Europe, and (2) the Oriental pears, consisting of varieties derived from *Pyrus sinensis*, the native pear of China and Japan. Many varieties of the so-called European pears have originated in America, but they are of course seedlings from pears of the European type. Examples of this are the Seckel, Lawrence, Clapps Favorite, Wilder, Howell, Tyson, and others. On the other hand, many of these varieties were imported directly from Europe, as for example the Anjou, Angouleme, Louise Bonne de Jersey, and the very popular Bartlett.

## COMMERCIAL CLASSIFICATION.

From the standpoint of the commercial orchardist another classification, however, is desirable, and for cultural purposes pears may be divided into three groups: Dwarf, standard, and Oriental.

The dwarf pear consists mainly of European varieties propagated on the quince root, the principal stock used for this purpose being rooted cuttings of a vigorous variety called the Angiers. The trees so propagated are dwarfed in habit, and are usually very productive and precocious in bearing. In case of certain varieties, conspicuously the Angouleme, the fruit is improved both in quality and quantity. On the other hand, the quality of the Seckel is not so good on the quince. Occasionally we have the anomaly of a pear growing naturally as a dwarf when propagated on the pear root, an example of this being the Japan Golden Russet; but ordinarily speaking, the dwarf pear means the pear on the quince root.

The second class, standards, consists of the European varieties propagated on the pear root. The stocks for this purpose may be either European pear seedlings, Japan pear seedlings, or rooted cuttings of some of the Oriental pears.

The third group, Orientals, comprises those pears which are partly or wholly of Chinese or Japanese origin. Only a small part of the commercial plantings are pure Oriental pears. Most of the important commercial varieties in this group are half-and-half hybrids between the Oriental and the European pears. The Oriental blood, however, which is in them gives them such a strong constitution and makes them such vigorous growers that they stand out very distinctly from the European tribe. In all orchard considerations these three types of pears must be kept continually in mind, as their requirements are usually quite different.

The principal dwarf-pear orchards in the United States are located in the northeastern section of the country. The most successful ones are to be found in southern New England, New York, Michigan, and on the eastern shore of Maryland. Some very fine small dwarf-pear orchards are known to the writer in New Jersey, Pennsylvania, and Virginia. The standard European pears are grown not only in the area above mentioned, but somewhat farther south. Very few successful orchards, however, of this type are south of the latitude of Washington or Cincinnati, except in the Allegheny Mountains, where the higher altitude compensates for being so far south. The Oriental pears, on the other hand, find their principal northern limits in about the latitude of New York or Philadelphia, and are very successfully grown as far south as the north line of Florida or even in the northern part of the peninsula of Florida. Their general range is distinctly more southern than that of the European pear. Their thick, leathery foliage and general drought and heat resistant characters enable them to withstand the hot, dry, sunny weather of the Southern States. Strange to say, on the other hand, these pears are very resistant to cold, and are grown successfully as far north as western New York and the southern part of the lower peninsula of Michigan. Along the northern boundary for this group, however, and on the Pacific coast, the European pear generally exceeds the Oriental in popularity and desirability. Where the Bartlett and other pears of that type really thrive well, the Orientals, which are of poorer quality, have no place. From Philadelphia southward the pears of the Oriental group are by far the safest and most profitable to plant at the present time. The writer is carrying on experiments in crossing the Le Conte and Kieffer with the Seckel, Anjou, and other choice pears, in the hope of securing in the resulting seedlings the high flavor and delicate texture of the latter with the vigor and productiveness of the former. The standard aimed at is Seckel quality and Kieffer productiveness.

## LOCATION, SITE, AND SOILS.

Although the pear may be grown on suitable sites anywhere within the area above outlined, certain localities have long been known to be especially favorable. The strip of country lying south of Lake Ontario in western New York, the fruit regions around the smaller lakes, the banks of the Hudson River, the vicinity of Boston, Mass.; portions of Long Island, N. Y., New Jersey, and the eastern shore of Maryland are striking examples. Very successful pear orchards occur in the fruit belt of Michigan, and to a less extent in southern Illinois, Indiana, and Ohio. In the higher portions of Maryland and Virginia are also some excellent pear orchards, but the mountain region seems to be less developed in proportion to its merits than most other parts of the country. Aside from the general consideration of soil and climate, nearness to large cities, convenience to transportation lines, railroad stations, or steamboat wharves often determine the most desirable location for the pear orchard.

As to the site for the pear orchard, the pear is not as exacting in this respect as the peach and many other fruit trees. The pear thrives on all slopes and exposures and on level land if the general region is adapted to it. In the matter of soils the pear is also recognized as a fruit which is not very discriminating. The ideal soil for dwarf and standard pears is a clay loam, with a porous clay subsoil. The dwarf pear requires a moister, stiffer soil than the standard to secure maximum results, although even dwarfs may be made to succeed on sandy soils by heavy manuring and high cultivation. Sandy soils with clay subsoil often prove very good for the standards. Many of the pear orchards on the eastern shore of Maryland and at least a portion of those in New Jersey are on this kind of soil.

For the Oriental pears the light, sandy peach soils may be considered the ideal ones. The Oriental pears will grow and thrive on almost any soil which is not too wet; but for the highest perfection in quality of fruit and smoothness and high color of the skin they should be grown on rather light, porous, well-drained soil, and on high or sloping locations, where the air drainage is good. In other words, the Oriental pears reach their greatest perfection in localities and sites where the peach succeeds well

## PLANNING THE ORCHARD.

In no phase of pear culture is the skill and experience of the orchardist more thoroughly brought to the test than in the preparation of the plans for the orchard. He must not only decide upon the varieties and the relative importance of each, and the distance apart of the trees, but must also consider the relative time of ripening of the fruit, so that it can be marketed with reasonable convenience with the facilities at hand, and he must also bear in mind questions of pollination, so as to have mutually fertile varieties which bloom at the same time, planted near together.

In all cases, when planting out an orchard of an acre or more in extent, it is best to make a preliminary survey of the ground, and then draw up a preliminary plan on paper. This need not necessarily be a plat, but should show the number of rows and the number of trees of each variety in each row. Dwarf pears are ordinarily planted at distances between 8 and 16 feet apart each way, standard pears about 20 feet apart, and Oriental pears about 30 feet apart. In the writer's own orchards the trees have been planted on a rectangular system, that is, instead of planting the trees 20 feet apart and in rows the same distance apart, in squares, they have been planted 16 feet apart in rows 24 feet apart. The reason for this is that in planting, fillers have been generally used, that is, temporary trees have been set out between those which were to remain permanently. By planting out the orchard, for example, with standard pears at intervals of 12 by 16 feet every other row of the 12-foot rows is a filler row. As the trees begin to crowd, these are taken out, and the trees are left 16 by 24 feet apart. In either case the rectangle approaches so nearly a square that it is perfectly convenient to carry on the operations of cultivating, spraying, etc.; in fact, it is more practicable to have the trees farther apart one way than the other, as this leaves a broader strip for plowing and more room for spraying and hauling out the fruit as the trees begin to fill the space completely. For dwarfs the distance of 12 by 16 feet was adopted, with a filler row between 16-foot rows, which makes the trees stand 12 by 8 feet. The distance for the standard pears is 16 by 24 feet, with fillers between the 24-foot permanent rows, the trees thus standing in the original planting 16 by 12 feet apart. In the Oriental orchard the distance is 24 by 32 feet, with a filler row between the 32-foot rows, making the trees stand 16 by 24 feet apart. It will be noted that each of the two latter distances is double that of the preceding, so that the orchards can be planted adjoining and the rows be continuous, which is a great advantage in plowing and cultivating. Furthermore, all the distances are multiples of 4, and this arrangement gives the convenient distance of 4 feet for planting truck crops, cowpeas, etc., in the young orchard.

## PREPARATION OF THE SOIL.

The pear, like most other fruit trees, is very susceptible to previous preparation of the soil. As a rule, it is best, if possible, to plan beforehand where the orchard is to be located, and begin the preparation of the soil one or two years before the trees are planted. A well-cultivated crop of Irish potatoes, or any of the hoed garden truck crops which require high manuring and thorough cultivation, may be considered as good preparation for the pear orchard. The soil, unless naturally very deep, should be plowed an inch or two deeper each year for a year or two in anticipation of planting out the orchard. In this way the soil will be materially deepened and enriched and its mechanical state improved.

These remarks apply more especially to dwarf-pear culture, but also have a considerable bearing on the behavior of Orientals and standards. The principal advantage in thorough preparation is the saving of time. The young trees start off more rapidly if the soil is previously thoroughly prepared. Orientals and Bartletts may be planted on newly cleared land when no other is available, but, as a rule, the land should be planted to a crop for at least a year or two before setting out the trees. Most soils suitable for pear culture have a more or less stiff clayey subsoil. It is a great advantage to thoroughly loosen this subsoil by plowing or subsoiling before setting out the trees. If the orchard is planted in the fall of the year, which is the preferable time in the Eastern and Southern States, the land may be subsoiled by following with a subsoil plow immediately after the turning plow. It is not necessary, however, to subsoil the whole area of the orchard unless this is desired for the cultivation of other crops among the trees. The land may be plowed first, and then a special preparation of plowing and subsoiling may be given to a strip about 6 feet wide on which the tree row is planted. This may be widened by subsoiling a strip around the trees each year ahead of the spreading roots until the middle is reached. Of course, very good preparation in many parts of the country for meadow or pasture land would consist in plowing it up rather early in the fall, then harrowing a strip on which the trees are to be planted. More orchards have been planted without subsoiling than with it.

### HOW TO PLANT OUT THE ORCHARD.

Each orchardist will no doubt develop some method of his own in planting out the orchard. There are many methods, however, of undertaking the work by which time is saved and accuracy secured. One of the simplest ways of planting out an orchard, and a very good one under certain circumstances, is to measure off the land with a tape-line or pole, driving a small stake at the end of each row around the orchard, and then with a one-horse plow, or other convenient implement, check off the field into squares. The trees are then planted at the intersections of the furrows made by the plow. On level land, with a skilled man to run the furrows, quite accurate results may be obtained by this method. As a rule, however, the writer has found another method preferable, namely, planting by stakes. The method by furrows is objectionable for two reasons: (1) In order to save digging the holes it was found desirable to plow out a deep dead furrow with a two-horse plow, making from three to five trips, and when this large dead furrow was thrown out it was impossible to use it as a planting guide with any accuracy; (2) difficulty was encountered in securing accurately laid-off furrows, especially on rough land or land where any sort of obstacles intervened.

The method of planting by stakes starts out essentially the same as the above method, by setting pegs and laying off with the plow. The pegs should be put a rod or two outside of the outer row of trees and parallel to it all around the block. These pegs may be quite small, split from a block of wood, and should be set accurately. A quantity of stakes should be made 4 to 6 feet long. The head man takes an armful of stakes, and beginning at the peg back of tree No. 1 drives a stake accurately behind it. At the same time an assistant, stationed at the opposite side of the field, also carrying an armful of stakes, places a stake at his end of the row. A third man with a supply of stakes is stationed midway between these two, and after the end stakes are driven the foreman sights between them and accurately locates the position of the middle stake while the helper drives it, thus setting the three stakes in line on each row. In the same manner the rows are staked out in the other direction. This is very quickly and accurately done unless hills are encountered, which are difficult to sight over, but by using a long pole for guiding the location of the stakes this difficulty may be overcome. The result is a stake marking each end of each row and a row of stakes across the center of the field each way marking the middle point of each tree row.

Taking the most convenient direction, the deep dead furrows are then plowed, and necessarily with them the center stakes, which must be reset by sighting. The trees are then brought into the field and the bunch of bundles required to plant each particular row, as shown by the plan on paper, is then roughly heeled in in the dead furrow at the end of the row. While up to this time considerable labor has been expended in preparation work, from now on the planting can proceed with great rapidity and accuracy. The planting gang should consist of four men, viz, the foreman, who holds the tree and tramples the earth around it; two shovelers, one of whom must be a good hand at sighting a straight row; and a fourth man, who prunes and drops the trees at about the places where they are to be planted. The foreman holds the tree in his hands in a vertical position and sights accurately its alignment with the center stake and the end stake beyond. The first shoveler stands in line with the cross row and sights on the center stake and end stake of that row. This results in easily placing a tree within an inch of where it should be. If any additional digging is necessary the two shovelers strike in with their shovels and remove the necessary earth. The tree is then set in place, and the mellow earth shoveled around it, the foreman trampling the soil firmly around the roots as it is thrown in. He keeps the tree in line on the row being planted, while one of the shovelers sees that it is kept in line in the other direction. In this way four good men can plant out easily from 500 to 1,000 trees in a day. When the planting is finished, a one-horse plow is used to fill in the dead furrows and to throw the earth more thoroughly around the trees.

## CULTIVATION.

The history of the pear orchard in all questions of cultivation should be considered as divided into two periods: (1) The young orchard before it comes into bearing; (2) the bearing orchard. It is necessary for complete success in growing pears that the ground should be thoroughly plowed each spring and kept in a good state of cultivation until midsummer. In the young orchard this involves a great deal of expense with very little apparent return unless some other crop is grown in the orchard. By growing the right kind of crop, especially one which requires high fertilization, instead of drawing from the soil and impoverishing it, the result is the enriching of the soil; in other words, the crop becomes a veritable nurse crop. The only disadvantage comes in a dry season when there is not enough water in the soil for both the trees and the crop, even though ample plant food may have been artificially supplied. The nurse crop also frequently prevents the thorough midsummer cultivation, which is so necessary in a dry season.

Of the truck crops grown in the pear orchard, almost any of the low-growing garden crops may be cultivated, such as cantaloupes, sweet potatoes, Irish potatoes, and cucumbers, as well as cabbages, beans, peas, beets, turnips, etc. Crops which have to be dug late in the season with a plow or other implement, such as Irish potatoes and sweet potatoes, are probably less desirable than such crops as cabbages, peas, beans, and similar crops.

During the first two or three years the truck crops can be planted in the first row 4 feet from the row of trees, and the tree row should receive the same cultivation or even more than the truck crop. After the third year, when the roots of the trees have begun to spread out through the soil and the tops cast a larger shade, the truck crops should not be planted quite so close. At five years of age it is usually best to abandon the outside row entirely, leaving a space of 8 feet. Most pear trees at six years of age begin to bear heavily and need all available soil moisture and plant food. Corn may be grown in the richer soils for the first year or two; but on the whole, any plant of as rank growth as indian corn can not be considered a desirable crop. Wheat, rye, or cereals, which do not allow cultivation during the spring and early summer, are decidedly objectionable. Unless the soil in the pear orchard is overrich, which is not apt to be the case, it should always be the rule to apply more fertilizer to the nurse crop than the crop itself removes. The crops should not be planted within 4 feet of the trees. This practice of growing other crops in the orchard is often condemned by writers and fruit growers on theoretical grounds, but in a practical way, if the above conditions are properly complied with, there are no serious objections to it. The young trees themselves require some fertilizer, but this will be considered later. By skillful management, the growing of vegetables or other crops in the young orchard for four or five years preceding bearing may be made to pay the cost of the improvement of the soil. The cultivation of young trees themselves is not very different from the cultivation of any other tender plant, and, as everybody is familiar with corn culture, we may lay down this rule: Cultivate the pear tree just as you would a hill of corn if you were trying to grow a specially fine hill of corn. Great care must be used to keep from injuring the trees. Hired help who have not had experience in cultivating trees, even though they have had experience in cultivating corn and other crops, are not apt to realize the injury that a touch of the singletree or parts of the harness may inflict on the tree. When growth starts in the spring, the young trees, if struck in this way, are likely to be very seriously damaged. To avoid this, a careful and experienced man should be employed to plow the first furrow around the trees. The singletree should be extremely short, as short as possible for the horse to conveniently work in. Unless some special device is used for fastening the tug at the end of the singletree, it should be protected by wrapping a piece of old sacking around it, so that in case a tree is struck it may not be seriously injured. Even with the utmost care, however, the young shoots are frequently broken off when they are from 3 to 6 inches in length by a mere touch.

In the plowing of the ground in the spring for the young orchard, it must be borne in mind that the dwarf pears do not thrive as well if the earth is plowed away from them as when back-furrowed around them. The quince root is of such a character that it prefers the excess of moisture, and the latter method serves to retain moisture, while the former has a somewhat drying effect. It is therefore usually best in the dwarf-pear orchard to continue plowing year after year toward the trees, and depend upon the cultivation and cross harrowing to level the land again. If the tendency to ridge becomes too pronounced, it may be obviated by plowing two or three furrows toward the tree row, and then back-furrowing in the middle of the strip, leaving two small dead furrows near the tree rows instead of one in the middle. These small dead furrows will be more easily filled by the cross harrowing. In the case of standards and Orientals, if the soil becomes ridged, it will do no harm to plow away from the trees to level the land.

One point should always be borne in mind in the cultivation of the pear orchard as compared with that of peaches, apples, and other fruits; this is, that the pear tree makes its growth very early in the season. Most of the annual twig growth on the trees, at least after the age of three years, is made within four to six weeks of the blooming time, and very little of it is made during mid-season and thereafter. Special attention, therefore, should be paid to the early cultivation of the pear orchard. Later in the season cover crops may be grown, or, if comparatively free from weeds, the orchard may be allowed to take care of itself. In case of young trees, plowing should usually be finished before the buds have swelled sufficiently to be easily injured by the horse when brushing past them. When the buds are dormant the injury is very slight; if, however, the buds are an inch or so long, many of them may be brushed off. It is often wise to plow the first two or three furrows with the one-horse plow while the trees are dormant, and then later, even though the buds may have pushed out, to finish the plowing in the middles with the two-horse plow. The cultivator should, if possible, follow the plow just before the buds have pushed out appreciably. The one-horse five-tooth cultivator is suitable for this purpose. This will mellow the ground and put it in a finely pulverized condition, which at that season of the year will enable it to retain its moisture for a fortnight or more. If possible, the trees should be allowed to bloom and to start their twig growth before the cultivator, with its accompanying danger to the buds, is again used. By cultivating the trees on a dry day, when the foliage and twigs are somewhat limp, the minimum amount of injury will be done. At least four or five cultivations at intervals of about ten days to two weeks should be given to the young pear orchard. In the meantime the other crops planted between the trees may require cultivation, but the cultivation of the pear orchard should proceed independently in case these crops are not ready for it.

In the bearing orchard the plowing in spring is, of course, the same, but the absence of other crops between the trees renders the cultivation much simpler and more economical. Having plowed the orchard, the cultivator, spring-tooth harrow, or some other form of harrow should be passed over at such a time that it will be most effective. The land can then be left until after the trees have bloomed, when a second harrowing, preferably in the opposite direction from the first, should be given. The ground should then be harrowed over about once in ten days, five or six times, keeping the soil in a finely pulverized state. If heavy rains occur, pounding the ground and compacting the surface, the crust which forms on drying out should be promptly broken before the soil becomes too hard.

It will hardly be possible to mention the many implements useful in the cultivation of the pear orchard. The disk harrow, the cut-away harrow, and the spading harrow are very useful types, and in certain conditions of the soil are very effective. The spring-tooth, the ordinary spike-tooth, the Acme, and even the weeder, are very good implements. The weeder, however, is not as desirable in the pear orchard as it is among peach trees, for the reason that the pear is deep-rooted, and can better withstand and profit by deep cultivation than the peach. As to the depth of plowing, the writer is inclined to favor rather deep plowing for the pear orchard. If the trees are set with the point at which they were budded 2 inches below the surface the first two or three furrows may be made about as deeply as a one-horse plow can go, namely, 4 to 5 inches. After the third furrow the two-horse plow can be used, and as a rule the land should be plowed as deeply as it will stand; in other words, as deeply as the soil will permit without turning up too much of the clay subsoil. It is usually wise, unless great care has been taken in previous preparation, to plow the middles of the pear orchard very deeply, turning an inch of subsoil to the surface each time. In this way the soil will be deepened; 8 to 10 inches is none too deep and less than 6 inches should not be considered deep enough. As the trees spread out and the root systems occupy the soil, the plowing may be an inch or two shallower than in the young orchard, but with this exception the depth should always be maintained. It is a great mistake to plow the orchard shallow for a number of years and then plow it deeply, for many of the roots will have developed at shallow depths, and the subsequent deep plowing will tear up and destroy them.

### FERTILIZATION.

Few soils really adapted to pear culture are fertile enough to support the bearing pear orchard without some assistance in the way of manures and fertilizers. If the soil is tolerably fertile, that is, capable of growing 40 bushels of corn per acre, the young orchard may need no assistance whatever until it has borne a heavy crop, after which, as a rule, some additional plant food will be desirable, if not absolutely necessary. As above suggested, however, young trees usually need to be fertilized individually during the first two to four years after planting out. For this purpose any good, complete fertilizer may be used, one containing 10 per cent of potash from muriate of potash, 7 to 8 per cent of phosphoric acid from acid phosphate or dissolved bone, and 4 per cent of nitrogen (half from nitrate of soda or dried blood and half from tankage, bone, or some other slowly available form or organic nitrogen). Before the trees have pushed out into growth the first spring after planting, a large handful (about one-third of a pound) should be thrown immediately around the tree and hoed or cultivated into the soil. When the tree begins to absorb soil water and push out its new leaves, it will at once feel the stimulus of this fertilizer, and as a result the leaves will come out large and of a dark-green color, and the twig growth will be robust and vigorous even though the trees are on poor ground.

The second year it is best to put the fertilizer in the bottom of the furrow after the first trip with the plow has been made on each side of the tree row. A handful of fertilizer should be strewn in each furrow for a distance of 3 or 4 feet each way from the tree. The second furrow is then plowed, the dirt being thrown on top of the fertilizer. If stable manure is to be applied, it may be put in the bottom of the furrow and covered up in the same way. It is a good plan to fertilize all the trees the second year with about 1 pound of commercial fertilizer to each tree, and then to give a special manuring with two to four shovelfuls of good stable manure to the weak trees and those growing in the poorest soil. If it is desired to continue fertilizing the trees individually during the third and fourth years, it may be done in the manner described, but the fertilizer may be placed in the second or third furrow from the tree instead of the first one. In succeeding applications it is better to fertilize the whole area of the ground rather than the individual tree, especially in the case of standards and Orientals.

In the fertilization of the orchard some general system of building up the soil as a whole should be adopted, and the three following methods are worthy of consideration:

The first method, which has already been discussed under "Cultivation," consists in applying fertilizers to truck crops grown as nurse crops in the orchard. The residual effect of the stable manure and fertilizers applied to the nurse crops is very beneficial to the soil and, therefore, to the trees in the orchard.

The second method consists in the use of green manures and the mineral fertilizers, potash and phosphoric acid. A very good proportion is three parts of acid phosphate and one part of muriate of potash. This mixture is applied at the rate of 400 to 800 pounds per acre, and will supply all of these ingredients necessary for large crops. The green manures, that is, crimson clover, cowpeas, etc., are depended on to furnish the nitrogen and the necessary organic matter to keep the soil in a high state of fertility. In the pear orchard the problem of growing the green manures is not a difficult one, for the reason that the tree-growth is made early in the season and the long growing period from midsummer to autumn is available for growing leguminous crops. If crimson clover is grown, it should be plowed under rather early in the spring to get the best results.

The third method, the simplest of all, consists in the direct feeding of the trees and the soil with fertilizers and manure. If the trees do not respond in a satisfactory manner to good cultivation and pruning, that is, if they do not throw out from 12 inches of growth on the dwarfs to 3 feet on the Orientals; and if they show the ordinary symptoms of starvation, that is, small fruit and small foliage, plant food should be applied to them until they grow out of this condition. In this respect the dwarf pear is much more exacting than either the ordinary standards or the Orientals. It requires high manuring and fertilizing, and the fertilizers must be applied very close to the tree, as the quince roots do not spread out like those of the pear.

Many old-fashioned fruit growers prefer to use wood ashes, stable manure, and ground bone for the fertilization of dwarf and other pear trees, and there is no question that these materials are very desirable, if not the best to use. As a rule, however, potash can be bought much cheaper in the form of muriate, and phosphoric acid cheaper in the form of acid phosphate, so that it is more economical to purchase these forms, and they are probably just as good.

It is an excellent practice to fertilize the bearing dwarf pear orchard in the manner above described for the young orchard. Three to six large forkfuls of stable manure may be applied in the furrow in the spring or thrown around the trees in winter, and from 1 to 5 pounds of complete fertilizer of the formula above suggested should be applied early in spring and cultivated or harrowed into the soil. Standards and Orientals will of course respond to good fertilization and cultivation, but as their root system is very widespread and deep, they do not feel the necessity of additional plant food as keenly as dwarfs, and do not respond to its application so readily.

In the use of potash and phosphatic fertilizers there is little danger of injury from an excessive amount, but nitrogenous fertilizers must be used with great care. Stable manure should be applied only in early spring, never in midsummer, and a light dressing, not to exceed six large forkfuls, is the maximum amount that may be used safely on each young tree, although trees bearing heavily will stand more. Care must also be exercised in the use of nitrate of soda, cotton-seed meal, blood, tankage, and other nitrogenous fertilizers, as it is rarely safe to apply more than 200 pounds per acre of any one of these materials. Bone, bone tankage, or other slow-acting and insoluble nitrogenous substances may be applied in the fall and winter if preferred and in larger amounts. To avoid waste, nitrate of soda and other soluble forms should not be applied until about the time growth starts. The danger in applying nitrogenous fertilizers and stable manure in excessive amounts or late in the season arises from the fact that the trees are stimulated to make a late and immature growth of the cambium and twigs, and are thus rendered susceptible to injury from winter killing and pear blight.

The methods of fertilizing above described are intended to push the pear tree into as vigorous growth as possible and cause it to bear the largest possible crops of the best-developed fruits. It is well known to most growers, however, that pear trees forced with stable manure and fertilizers and by good cultivation become very susceptible to blight, and when attacked are most severely injured by it. As a result of this, growers are continually restrained in their efforts in fertilizing their pear orchards, and generally aim to keep their trees in a semi-starved condition. As to the wisdom of this policy, we are not prepared to decide definitely, and each grower must be left to decide the matter for himself; but it may be said that while a moderate restraint in the fertilization may be considered proper as a rule, it is better to take some risk at least, so that if crops are produced the fruit will be of such quantity and quality as to be profitable.

### PRUNING.

There is no branch of pear culture more commonly neglected by the average commercial orchardist than that of pruning, though the subject has received very careful attention from certain men. In foreign countries, especially in France and Belgium, great attention is given to the details of pruning. Great labor is often expended on the trees in the nursery and in the orchard in developing them into geometrical forms. While the extreme conventional forms of trees may properly be looked upon by American commercial orchardists as a waste of time and money, yet the theory is correct. There are practical reasons for pruning bearing fruit trees to certain ideal types. For the American orchardist there are three main types of pear trees to be considered—the pyramidal form, the vase form, and the natural form. Largely through the efforts of Patrick Barry, Marshall P. Wilder, and other leaders in American pomology of the last generation the pyramidal form of pear tree has been considered as the proper ideal, and is in fact the almost exclusive form for American orchards. In the opinion of the writer, however, the pyramidal form has been advocated to an extent far greater than it deserves. The vase-form tree, while somewhat more difficult of development and somewhat less natural, is in many ways far superior to the pyramidal form. The natural form finds its principal advocates among those who know little or care little about pruning, and seem to find consolation in falling back on the theory that nature knows better than man what is best for the tree. They overlook the fact that the fruit tree is an entirely artificial product and is under artificial conditions. Were the theory that nature knows best to be consistently followed, we should only plant the seeds of fruit trees, never bud nor graft them, nor cultivate, spray, nor carry on any of the other horticultural operations on which the success of fruit raising depends.

There are arguments pro and con in favor of each of these three forms. The pyramidal form of tree is with most varieties more natural than the vase form. It permits heavy cutting back and thinning out without interfering with the general scheme of pruning. This form is so nearly that of the natural tendency of most fruit trees, especially while they are young, that it requires little effort to balance or curb undesirable tendencies. It has the disadvantage of not being adapted to such extremely low heading as the vase form, of having a large portion of its fruit more difficult of access, and in case of pear blight, the branches are so arranged that the life of the tree is more quickly imperiled by the disease.

The vase form of tree has the disadvantage of requiring considerable skill during the first few years of pruning. It is somewhat unnatural to most varieties of pears while they are young, and it therefore requires considerable effort to keep the tree properly balanced and to develop successfully the desired form. It has the advantage of being the easiest tree to work around, the easiest for thinning and picking the fruit, and to prune after the first few years. It is also the most convenient tree to spray, and is a thoroughly satisfactory form from the standpoint of fruitfulness. In pear orchards, however, one factor alone should be sufficient to lead to the adoption of this style of pruning, namely, the much greater ease with which pear blight can be fought and pruned out. The low-headed vase form of tree, with the body 16 to 18 inches high and the limbs and main branches cut back so that they fork at about 12 to 18 inches, and with the main limbs kept entirely free from fruit spurs and fruit-bearing branches, is by all odds the safest form of the three to withstand blight.

The natural form of pear tree involves very little pruning, merely sufficient to clear out the interlocking branches and to remove water sprouts and an undesirable surplus of limbs at any point. It is the cheapest because it requires the least work. However, when such trees come into bearing they usually overbear certain years; with many varieties of pears, the Kieffer, for instance, the trees are likely to break down with their load of fruit, and require several years to recover. The saving of expense in pruning by no means compensates for the loss.

### THE VASE FORM.

In order to secure the vase form of tree, which the writer advocates (Pl. XLIV), the nursery tree when planted in the orchard should be pruned to a straight cane about 18 inches high. The Garber and some other very spreading types may possibly stand 2 feet in height. On the other hand, very upright growers like the Kieffer, the Bartlett, and, as a rule, most of the dwarf types, should be pruned to from 12 to 18 inches. This straight stock, if properly planted out, will throw out a number of shoots the first year. When the buds have pushed out an inch or so they should be rubbed off the lower half. When the new growth is about 6 to 10 inches long the trees should be visited and three branches selected for the future main limbs. These three branches should be arranged in a circle so as to form an inverted tripod, and should not radiate from one point, whatever the type of tree adopted, but should be several inches apart vertically. Having selected these three main twigs, all the other growth should be pinched off at the tip, allowing these shoots to become strong, vigorous twigs; and in a good tree they may reach a length of 3 to 6 feet the first year. If any one of these shoots shows a tendency to outgrow the others, it

FIG. 1.—KIEFFER PEAR ORCHARD, 4 YEARS OLD, SHOWING VASE FORM OF PRUNING PRACTICED BY M. B. WAITE. MARYLAND.

[Photographed in October.]

FIG. 2.—YEOMANS DWARF PEAR ORCHARD, 36 YEARS OLD. WALWORTH, N. Y.

[Photographed in May.]

may be pinched back when 10 inches or so long, in order to retard it until the others catch up. In the winter, or preferably just before the buds swell in the spring, the three shoots which have been selected for the main limbs may be headed back, preferably leaving a branch from 12 to 18 inches long, making the inverted tripod level across the top. A length of 12 inches is best for dwarfs, while a greater length is more suitable for standards and Orientals. All other twig growth is removed. The following spring, when the buds are pushing out, all of them starting on the trunk and main limbs, except on the upper 6 inches, should be carefully removed by rubbing with the hand, protected with gloves if necessary. When the new growth has pushed out 8 or 10 inches it is often desirable to go over the trees again, removing or pinching back any undesirable sprouts. For the next winter's pruning two of the most desirable twigs on the upper part of each of the three arms of the tripod which extend upward and outward should be selected and cut off to 12 to 18 inches, and the other branches of the tree should be again removed. The third year this operation is repeated, leaving a pair of outwardly diverging twigs, extending upward on each shoot of the previous year. By the third pruning it will be wise to begin to leave certain small twigs which extend laterally or downward as temporary fruiting branches. These twigs should be such as not to interfere with the strong-growing upright branches, which are intended to form the main framework of the tree. At this stage of the development the principal attention is devoted to this main framework of branches. Every twig which is left in the tree is carefully considered as a future branch. These temporary fruiting branches form the only exception to this rule. The fourth and fifth years' pruning should be continued on the same line, but more attention should be paid to leaving fruiting branches. As the top of the tree develops, after the fifth year, of course very many fruiting branches will be formed, and later on all such branches which have been left on the first five years' growth should be cut away entirely, but in order to avoid the loss of fruit during the earlier bearing years these branches may be allowed to form temporarily and to bear several crops of fruit, and may be disposed of when they can be spared. After the fifth year it is rarely possible to continue the ideal form as far as each individual twig is concerned. The general shape and style of the tree is determined entirely by the previous pruning. Efforts should be directed simply to keeping the tree in the form already attained. (Pl. XLIV, fig. 1.)

The pruning must vary considerably with the variety of the tree, and is naturally different in case of dwarfs, standards, and Orientals. The dwarf pear, with its usual tendency to overbearing, should be continually headed back to about 8 to 10 inches of annual growth. If an excessive number of fruit spurs develop on top of the tree at the expense of vegetative shoots, the vegetative tendency of the tree may be promoted by cutting back even into 3-year or 4-year-old wood. This will remove some of the surplus top and cause the tree to throw out strong, vigorous sprouts, which may be headed the next year. In heading back old wood on bearing trees, if possible the branch should be cut off where a new young sprout or branch extends outward, as by so doing the new branch will take the place of the old one, and will receive the tremendous stimulus caused by the concentration of the sap into the smaller twig. In this way a continual renewal of the bearing wood can be kept up. One of the most striking cases of this with which the writer is familiar is the Yeomans pear orchard shown in Pl. XLIV, fig. 2. In the case of standard trees, if the main twig growth exceeds a length of 18 inches it is usually best to head back everything above that length. In this way long, slender, drooping branches can be avoided and the branches made stocky and strong and capable of bearing a very large load of fruit. Trees like the Kieffer, if allowed their own way, develop fruit spurs in abundance. These form on the ends of long branches as well as in the body of the trees, and in a favorable season the tree loads itself down with fruit. The result is disastrous, for the slender branches are unable to support the tremendous load, and break off within about a foot of the trunk. The heading back will entirely prevent this destruction and tend to keep the tree in continuous bearing.

### THE PYRAMIDAL FORM.

The pyramidal form (Pls. XLV and XLVI, fig. 1) is a much simpler and easier form in which to train most varieties of pears, because it conforms essentially to the natural tendency of the trees. It is usually best to head the trees to a straight cane in planting them out, as previously described, though this is not necessary if the head has been formed in the nursery at the point desired by the orchardist. This is very rarely the case, however, as most nursery trees are headed too high. If the tree is headed at the proper height in the nursery, it will simply be necessary to cut the leader back to about 6 inches and to trim three or four of the secondary branches to about 3 inches. The tree may then be allowed to go during the season with very little pruning. It may be necessary to go over the trees after 6 or 8 inches of growth has been made and pinch off an occasional shoot which has not developed in conformity with the pyramidal form. Sometimes two leaders will form nearly equal in size. One of these should be pinched back and the other allowed to remain.

In the winter pruning the central leader is first selected and cut back to the height at which the next whorl of limbs is desired. In the dwarf pear this should be about 12 inches; in Bartletts and other

FIG. 1.—MILLS ORCHARD, SHOWING 3-YEAR-OLD DWARF PEARS. SOUTH HAVEN, MICH.

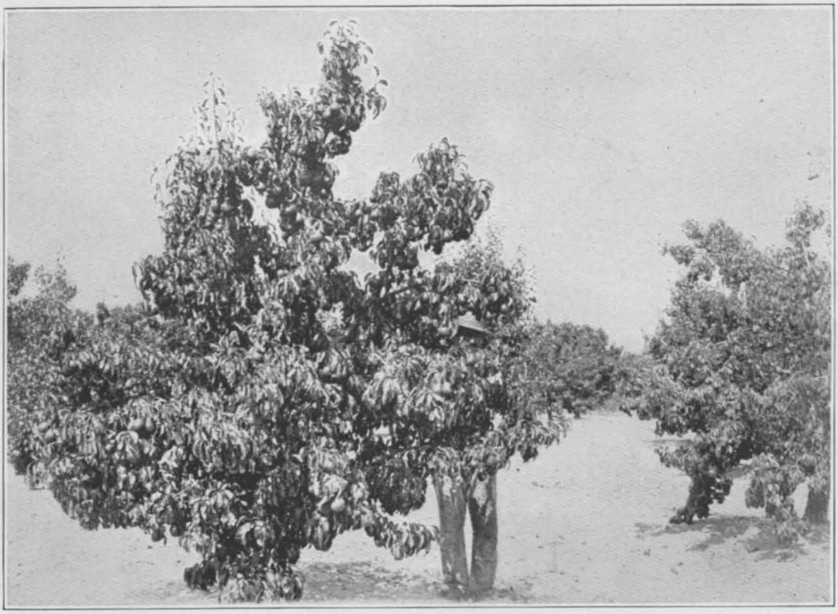

FIG. 2.—MILLS ORCHARD, SHOWING LOUISE BONNE DE JERSEY TREES HEAVILY LOADED WITH FRUIT. SOUTH HAVEN, MICH.

FIG. 1.—STANDARD PYRAMIDAL MANNING PEAR. EXPERIMENT STATION, SOUTH HAVEN, MICH.

FIG. 2.—SHERWOOD ORCHARD, WITH PEARS, PLUMS, AND APPLES IN ALTERNATE ROWS, SHOWING YOUNG KIEFFERS JUST COMING INTO BEARING. WATERVLIET, MICH.

standards about 14 to 16 inches; in strong growing Orientals, like the Kieffer and Le Conte, 18 to 20 or even 24 inches may be proper. The lower whorl of main limbs is then examined and about three or four branches are selected. These are cut back to a length of about 12 to 18 inches, or about two-thirds the length of the leader. All other branches or twigs interfering with this main framework are then removed. In the next year's pruning, at the conclusion of two years' growth, the central leader is again selected and cut off at the same length as in the previous year, the 1-year-old whorl of branches at its base is examined and pruned in about the same manner as the previous year, leaving three or four twigs to form main limbs, and the lower whorl, which now has two years' growth on each branch, is treated in much the same way that the pyramidal top has been treated, namely, the leader for each branch is selected and headed back, leaving it about two-thirds as long as the leader at the top of the tree. At the base of the leader on the 2-year wood about two or three secondary branches are selected and headed back, so as to subordinate them to the leader, and the other twigs on these branches are cut off. All of these main branches are selected with reference to their forming the framework of the tree exactly as described in pruning for the vase form of tree. Temporary fruiting branches may be left in the same manner also as described in that form. Water sprouts and limbs in undesirable places are of course removed.

The third-year pruning of the pyramidal form proceeds on the same lines, the upper part of the tree being pruned exactly as in the previous years, the only addition being that one more joint is added to each main branch and one more set of lateral branches has to receive attention each year. The pyramidal form of tree does not change, and the general plan of pruning continues the same through its entire life. The only thing to avoid in this type of tree is the tendency to become too thick and bushy in the repeated heading back which it receives. This defect is shown in Pl. XLVI, fig. 1. To avoid this the pruner should be prepared to thin out unnecessary branches as well as to cut back. Fruit spurs will begin to form on the branches after the third year. These may be left temporarily and afterwards cut away. It is undesirable even in the temporary form to allow young branches to become thickly grown with lateral fruit spurs, for the reason that such spurs are not nearly so well nourished as those on smaller branches carrying vegetative shoots, and furthermore such branches are a great deal more liable to destruction by pear blight. These numerous lateral fruit spurs when in bloom afford many opportunities for blossom-blight infection, and when such a branch is attacked by blossom blight the disease has only a very short distance to run from the fruit spur into the main limb, which it can girdle with a minimum amount of diffusion.

### THE NATURAL FORM.

In each of the other two forms of fruit trees the aim is to curb the tendency of the trees and their individualities. The tree is made to conform to the ideal in the mind of the pruner. If too many upright branches are thrown out they are headed back and made to sprout laterally; but, on the other hand, if the tree has a spreading or drooping tendency the lower branches are pruned off and the more upright ones are encouraged. In this way all varieties are made to grow as nearly alike as possible. It is by no means entirely possible, however, to entirely curb the natural tendencies, and it can be done only approximately. The natural form (Pl. XLVI, fig. 2), on the other hand, allows the tree to develop its own individuality. But some pruning is absolutely necessary, even if the idea of the natural form is to be carried out. In planting out, the branches may at least be headed back to spurs 3 or 4 inches long. As far as pruning is concerned, the trees may then be practically neglected for the first two or three years, but it is better to look them over every year and remove water sprouts and any branches which interlace and chafe and to examine for any wounds which should receive attention. Trees of this sort will come into fruiting earlier than those headed back and manipulated into an ideal form, for the reason that the vegetative tendency is not encouraged at all. As soon as the reproductive tendency develops it is allowed unrestricted course. However, the difficulties of reaching the fruit in the case of tall pyramidal trees, the tendency to break down in the Kieffer and a great many other varieties, and above all the danger of pear blight of this form of tree, make it undesirable in actual practice. Even in case of the natural form, where very little pruning is intended to be done, the writer advocates low heading. The trunk of the fruit tree has lost its function. It is an unnecessary and expensive thing for the tree to construct. It renders the tree more liable to disease, and by elevating the top from the ground increases the danger of its being blown over and of the fruit being blown off. Every inch of additional height increases the expense of pruning, spraying, and especially of picking. The trunk of a forest tree forms a very conspicuous part of the tree itself, and in the struggle for existence, especially among young trees in the forest, the tall growing trunk is an absolute necessity to the species. The effort on the part of each individual tree of the forest is to rear its top up to those of its neighbors. The struggle for light and air causes the tree to develop its trunk, which becomes very useful to man in many ways. The trunk of a forest tree, therefore, has gained our respect through its usefulness and beauty. On the other hand, even the native forest trees when situated in the open field grow a very short trunk. Oftentimes enormous oaks, with a spread of perhaps 100 feet, have only a few feet of trunk. Orchard trees, which are not only planted in open ground, but are also given proper spacing and cultivation, are entirely removed from the struggle for existence which competition and crowding brings about. The trunk of the pear tree, therefore, may be looked upon as entirely superfluous. In a fruit tree, the part that does the work is the top. In other words, in pear trees we should seek to develop the top as much as possible. The tree carrying the greatest amount of foliage and the greatest number of properly placed fruit-bearing branches is the ideal tree.

### THINNING THE FRUIT.

No discussion of pear culture would be complete without including this important operation, and as it belongs on theoretical grounds with pruning, we may consider it here. It is a great mistake to allow pear trees to overbear. When the fruit is about an inch in diameter the trees should be gone over carefully and all the surplus pears, over and above what the tree can mature properly, picked off. Each branch should be examined, and, with the size of the mature fruit in mind, the number reduced to the proper amount for that size of branch. All imperfect, wormy, or distorted specimens should of course be picked off first, and only those which are expected to make fancy fruit left behind. Unfortunately, no general rule can be given to guide in thinning pears. The rule of one fruit to 6 inches, which commonly guides the peach grower in thinning peaches, can not be definitely applied to pears. Experience is the only guide, and the grower may expect to allow a few trees to overbear before he learns the lesson of just how much to thin. Thinning not only improves the quality of the fruit of the current season, but it places the tree in better shape to bear the next year. As a rule, greater profits are secured by regular annual crops than by heavy crops during occasional years, for it commonly happens that such seasons are the very ones when fruit is plentiful and cheap and the profit in handling it very small.

## DISEASES.

### SCAB.

Pear scab, caused by the fungus *Fusicladium pirinum*, is one of the worst diseases in the northern portion of the districts in this country where pears are grown. It is a serious disease, however, as far south as Maryland and Virginia. It rapidly diminishes in severity in the States farther south. The disease is much affected by the weather in spring. If dry, sunny weather prevails from the time the bud scales open until the pears are an inch or more in diameter, the amount of scab will be very small, but if there is much rainy, damp weather, especially periods with intense humidity, scab becomes a very serious pest, so much so, indeed, that the entire crop is often ruined. The disease attacks the blossom buds before the petals have opened and new infections continue to take place, especially during the early periods of growth of the young fruit. After the fruit attains an inch or more in diameter and the cuticle becomes somewhat firm and thickened, the more resistant varieties, like the Angouleme, Kieffer, Lawrence, Clairgeau, Howell, Le Conte, and others, become practically immune for the rest of the season. On the other hand, very thin-skinned varieties, like Flemish Beauty, Seckel, White Doyenne, and others, retain their susceptibility during the greater part of the summer, and are much more severely attacked by the disease on this account. The scab fungus may be very effectually prevented by spraying with Bordeaux mixture. This has been repeatedly demonstrated by experiments, and is in common use by the better class of pear growers. The standard Bordeaux mixture should be used. This consists of 6 pounds of copper sulphate, 4 pounds of stone lime, and 50 gallons of water. The first spraying should be done after the cluster buds have opened so as to expose the individual flower buds, but before the petals have opened. The second spraying should be made about ten days later, or just after the greater part of the petals have fallen. The third treatment, if the weather is very damp, may be promptly made within five or six days after the second, or if ordinary sunny weather prevails ten days to two weeks should elapse. The fourth treatment should be about two weeks later. This will ordinarily be sufficient to prevent at least 90 per cent of the disease. Unfortunately, scab is so much affected by the weather that in a bad spring it is very difficult to do thorough work in preventing the disease on Flemish Beauty, Seckel, and such sorts. The grower need not be discouraged, then, if a good deal of the scab survives in spite of the treatment. On the other hand, in a very favorable, dry spring most varieties of pears will develop comparatively free from the disease without any spraying, and one may have the satisfaction of seeing his neighbor secure a fine crop of perfect fruit without going to the expense or trouble of spraying; but, as no one can tell beforehand what the weather will be, the only safe way is to insure a good crop of fruit by spraying the trees ahead of possible infection.

### LEAF-BLIGHT.

Leaf-blight, caused by the fungus *Entomosporium maculatum*, is another of the serious fungous diseases of the pear. It seems to be favored more by dry, hot weather than the scab fungus. It begins to be serious in proceeding southward, where the scab begins to decrease. While it may injure nursery trees and pear seedlings in New England, New York, and other northern States, it rarely becomes important until at least as far south as New York City. In Maryland, Virginia, and farther south it becomes the leading fungous disease of the pear. It covers the foliage with small, round spots, causing the leaves to drop off by midsummer or before, and causes the fruit to become spotted and frequently to develop one-sided and to crack open. Certain varieties are more resistant than others. The Oriental varieties are particularly resistant to pear leaf-blight, especially the Kieffer. In the Gulf States, however, the Le Conte often becomes defoliated by it. Of the European varieties, the Lawrence seems to be especially free from it in Maryland and Virginia. On the other hand, the Bartlett, Howell, and the ordinary European varieties suffer with it severely. Pear leaf-blight does most of its work after warm weather comes on, and seems to be little affected by the weather changes. At least, it appears regularly at about the same time each year, although if the weather is very dry and hot its defoliating effect becomes more pronounced.

Pear leaf-blight yields very readily to treatment with Bordeaux mixture. On adult trees there is scarcely any disease which is so thoroughly preventable. Where this disease alone is to be treated, a thorough spraying when the trees are in full foliage, about two to four weeks after the blossoms fall, and then a second spraying two or three weeks later, will almost completely obliterate the disease for the season. If the trees have been sprayed early in the season for scab, all that will be necessary will be to give one additional thorough spraying about a month or six weeks after blooming time. In case of young trees or nursery stock more spraying is required. Pear seedlings or other young trees which continue their growth throughout the season require to have the new foliage protected by the spray as fast as it appears. Five or six sprayings, at intervals of ten days to two weeks, are necessary in dealing with leaf-blight on such plants. Paris green may be added to the Bordeaux mixture in spraying for scab and leaf-blight, and a number of insect pests will be destroyed at the same time. The second and third treatments for scab are just in time for codling moth, while the time of the last treatment for leaf-blight is about right for spraying for the pear slug.

### ROOT ROT.

This disease removes thousands and thousands of pear trees annually in a most obscure and insidious manner, very frequently without the grower actually knowing what is the cause of the trouble. The young trees may start off satisfactorily in the orchard, and after growing three or four years certain trees push out feebly and show decided weakness and feebleness without any apparent cause. In a year or two they are dead. Others may make a fair growth during the early part of the season, but when hot, dry weather comes on the leaves turn yellow and either drop off or in extreme cases shrivel and hang on the tree without dropping off. On digging up such trees a large part of the root system is found to be dead. The trees are actually starving to death in good, well-cultivated, well-fertilized soil. Older trees in bearing when first attacked by this disease usually overbear, producing such a large quantity of small fruit that they can not mature it properly. Frequently they are blown over or may be readily rocked over by pushing them back and forth. The Oriental pears, with their great vegetative vigor, are remarkably free from this difficulty, as a rule. However, they are not perfectly immune from the disease, and losses from this cause even with them sometimes reach as high as 10 per cent or more by the time they are in full bearing. European pears on Japan stocks seem to suffer more from this disease than the same varieties propagated on the French stocks. In Maryland, orchards are sometimes practically destroyed by the root rot. The writer has seen a young orchard five or six years old in which more than half the trees were affected. Another orchard of Bartlett pears had so many trees diseased that when the grower dug them up he concluded there were so few healthy trees left that he gave up the orchard and cleaned off the land entirely.

There is no satisfactory way known at present to deal with root rot. The affected trees may be stimulated with stable manure, good cultivation, etc., so that they will stand up several years longer than they otherwise would, but on general principles one may conclude that the proper method of procedure is to pull out and burn up all positive cases of the disease. This disease needs thorough investigation.

### PEAR BLIGHT.

This serious disease of the pear was discussed in the Yearbook for 1895; hence it will not be necessary to go into details here. The disease, which is caused by a microbe, winters over in the tree and starts to spread the following spring through the agency of insects which distribute it on the blossoms. The honeybee and other flower-visiting insects work over the blossoms so thoroughly that the disease when it has a good start in the spring may spread like fire through the orchard. The young twigs, especially the tips, are also starting points for the disease after the blossoms are gone. Less frequently the disease may start on the fleshy bark of the trunks and branches, although it is necessary for some puncturing insect, bird, or other living thing to carry the germs and introduce them.

The best way to fight this disease is to prevent the blight from wintering over by carefully going over the trees in the fall and again in the winter and early spring and removing every case of hold-over blight. The germs which are to start the infection the coming year are all in the tree within easy reach of the operator. It is only a question of skill and thoroughness on his part as to whether they are allowed to survive or not. It is usually best to go over the trees in summer as well, and make a fight against the blight during the growing season. This, however, is not as easy to do successfully as to cut it out in the fall, for the reason that new infections are continually taking place during the growing season, and new cases of blight may be already in the tree but not sufficiently developed to attract the attention of the operator. In cutting out the blight, great care must always be taken to cut on healthy wood well below the lowest point discolored by the disease. It is usually safer to cut at least a foot or more on apparently sound wood, although by carefully studying the case it may not be necessary to go so far below.

An important matter in cutting out the blight is to carry along some disinfecting solution with which to sterilize the knife or other tools used. For this purpose any one of the following solutions may be used: Mercuric chloride, or corrosive sublimate, 1 part to 1,000 parts water; 5 per cent carbolic-acid solution; or, a solution of chloride of lime. The first may be best prepared by purchasing tablets of a definite amount at a drug store. These tablets can be kept in a small bottle, and a pint or quart bottle filled with water and one of the tablets added. Upon concluding work the bottle should be emptied to avoid the danger of poisoning children or unsuspecting persons. By this means the danger of using this deadly poison may be avoided. Carbolic-acid solution may be prepared by simply adding a tablespoonful or more to a bottle of water and shaking it up. The saturated solution, which contains about 5 per cent of carbolic acid, is the proper strength to use. A solution of chloride of lime will answer about the same purpose and is made by adding about 20 parts of water to 1 part of the commercial chloride of lime, shaking it up and pouring off the clear liquid. This is only fit for use while fresh. Any of these solutions can be carried by the operator, and a strip of cloth a yard or so in length should be fastened to the clothing, leaving one end hanging free. When cutting into active blight, the ends of the cloth may be kept saturated with the disinfectant and the knife sterilized by wiping before using it on the sound wood. It is also better to wipe off the wound on the sound wood with the saturated cloth, otherwise there will be the danger of leaving the blight germs on the cut surface and merely starting the blight over again. A knife used to cut into blighting tissue becomes subsequently a veritable inoculating instrument, and should always be sterilized before use on healthy tissues.

## PICKING AND MARKETING.

The methods used in marketing pears vary so greatly in different parts of the country that it would be impossible to describe them all in detail here. It is only possible, therefore, to give certain general considerations in regard to the matter.

The season of the year, whether summer or winter, the distance from market, the purpose for which the fruit is intended, as well as many other conditions peculiar to the markets of different cities, all have their effect in determining the methods used by the successful pear grower. The California grower packs his pears, mostly wrapped in paper, in neatly constructed boxes, shipping them in carload lots to New York, Boston, or other Eastern cities, or perhaps to London. The fruit is sorted and packed directly after it is picked from the trees, and is expected to ripen in transit and open up in prime condition for eating 3,000 miles or more from the orchard. The grower of the Le Conte and Kieffer pear in the Gulf States also packs his fruit in wholesale methods, using barrels or boxes, and ships it in car lots, or sometimes even in train lots, to Northern cities. On the other hand, the Eastern gardener may ripen up a few bushels in his house and deliver them direct to his retail or wholesale customers. Large quantities of pears are consumed by the canneries, both on the Pacific coast and in the Eastern States. The large crop of Kieffers, which is now getting to be such an important factor in the pear market of Eastern cities during the autumn months, is very largely taken up by the canneries, especially in Baltimore, and the trade in canned Kieffer pears is very rapidly increasing. For the canning trade the pears are almost always shipped in baskets of the type of the Maryland and Delaware peach basket, and the baskets are generally returned to the grower to be used over and over again. The price paid is usually so low that the cost of the baskets is an important item if they are not returned. The price is often as low as 15 to 20 cents a half-bushel basket, and 25 to 30 cents is considered a good price. At this price Kieffer-pear growing is immensely profitable. This can be readily understood when we realize that the yield is often more than 1,000 baskets per acre.

One important point for the inexperienced pear grower to determine is the exact time for picking the fruit. The pear is quite exceptional as compared with the ordinary orchard fruits in that it is much better if picked from the tree before it is ripe, and then ripened up either closely packed in a box or stored in large quantities in a tight room. Very few pears are at their best if allowed to ripen on the tree. As choice a pear as Clapps Favorite becomes dry and mushy at the core and very poor in quality if allowed to hang on the tree, while the same fruit, picked when firm and hard, but full grown, and ripened indoors, will be of an even consistency, juicy and delicious. During the last few days that the fruit hangs on the tree the development of the hard, woody kernels, the so-called stone cells of the pear, proceeds rapidly. Picking before the fruit is ripe seems to partly head off the development of these stone cells, and the subsequent ripening processes still further soften and disintegrate them. Among the pears of medium and poorer quality, such as the Duchess, Kieffer, etc., the ripening process may almost be said to make the fruit edible, at least make it fit for a dessert fruit. Kieffers allowed to hang on the tree until they are full colored and ready to drop have the maximum amount of stone cells; in fact the portion surrounding the core becomes almost a mass of woody matter under these circumstances. If, on the other hand, the fruit is picked when it first attains full size, or even a little before, and is ripened in bulk in the dark, it will color up a beautiful delicate yellow, frequently with a red blush, and soften evenly throughout, making a fairly good pear to eat out of the hand and a most excellent canning and cooking fruit. Pears allowed to hang too long on the trees when they are apparently ripe and soft will be found to have merely a shell, about half an inch thick, of ripened pulp and a large central portion either too hard to eat or filled too compactly with stone cells.

Generally, pears may be divided into two main classes in regard to ripening methods, namely, summer pears and winter pears. All fruit ripened with or before the Bartlett may, for convenience, be classed as summer fruit, although of course in the Southern States autumn varieties of the North, like Seckel and Duchess, really are summer fruits. The summer pears require but a short time, on account of their perishable nature and the high temperatures prevailing at picking time, to reach an eating condition after they are picked. It becomes necessary, therefore, in most cases for the grower to pick the fruit and pack it at once into the packages and ship it to market. The fruit will even then arrive none too soon in most cases to suit the wholesale buyer. Summer pears should always reach the wholesaler in a perfectly hard, firm condition, or at most just beginning to become soft enough for eating. The retail dealer will, therefore, have time to handle the goods before they spoil. They will usually ripen up on his hands in ample time for him to sell them. The autumn and winter fruit, however, having much firmer texture and requiring longer to soften, should usually be partly ripened before it is started off to market. Pears like the Kieffer color up fully before they are soft enough to eat, and can usually be shipped to the commission houses while full colored, yet perfectly firm and sound. As a general rule, summer and fall pears should be picked from a week to ten days before they would ripen on the tree. The grower determines this point by several kinds of indications. In the first place the size and appearance are guides to him. As the fruit approaches maturity the dead-green color of the immature fruit is replaced by a clearer, more transparent, and lighter-green appearance, which has to be seen to be fully understood. Again, certain wormy specimens attacked by the codling moth will begin to color up and fall from the trees. These, of course, are a sure indication that the normal pears will ripen shortly. Upon taking hold of the fruit and lifting it gently, if it is approaching maturity and ready to pick, the base of the stem will part rather easily from the twig at the proper separating point. Of course, if the fruit is immature the stem is apt to break at any place, although it may break off at the joint, but the ease with which the stem parts from the twig is a very good indication of maturity.

Pears should always be picked carefully, without bruising, with the stems on. They should be laid carefully in the picking baskets, which should hold half a bushel or so, and then be hauled to the packing house or other convenient place and at once sorted into grades, and either packed and shipped or placed in the ripening house for future shipment. It is usually better in most cases, especially with summer fruit, to pick the trees over two or three times, although this is not absolutely necessary, and unless the trees are heavily loaded may not be worth while. When the fruit has not been properly thinned and the trees are overloaded, many growers begin to pick the fruit long before it is full grown and send it to market. By this means the trees are not only relieved somewhat, but the fruit that is left swells to the largest possible bulk; moreover, satisfactory returns are often secured from the early pickings. This method is particularly successful with Clapps Favorite and Bartlett. Both of these varieties will ripen up tolerably well when they are not much more than half grown. The same principle is successfully used in handling Le Conte and Kieffer pears, but these should be nearer maturity to be good. There is one great advantage in the application of this principle of premature picking in case of these two great varieties, in that it distributes the marketing season over a longer period, and thus tends to give the country time to consume the crop without any glut in the market.

A Kieffer orchard skillfully managed, therefore, may be picked over in the latitude of Maryland about September 15, and then successive pickings may take place for three or four weeks. The earlier picking will be marketed and sold while the later fruit is still on the trees, and by a little attention to storing the later pickings in a cool place the fruit may be marketed from September 20 to Thanksgiving time or later without cold storage. Cold storage, of course, still further lengthens the possibilities of the marketing season for any given variety. Pears may be put in cold storage in about the same way as apples, the temperature required varying from 33° to 38° F. They are usually stored at a temperature a few degrees higher than that in which apples are stored, in fact are given the treatment of summer rather than winter fruit. Unfortunately, pears do not stand cold storage as well as apples. This is especially true of summer pears. Extra precautions are necessary in both picking and handling the fruit before it is put in storage, and in the subsequent handling after it is taken out. Cold-storage pears are very apt to blacken and become unsightly after they are taken out of storage, even though they may be in fairly good condition. Summer pears, particularly, are inclined to lose their flavor in cold storage. Kieffer, Anjou, Bosc, Easter, and some other late varieties when put into cold storage hard and green seem to stand the treatment very well and come out several weeks afterwards in nearly the same condition as that in which they went in. They may then be brought into a warm room for a few days before they are wanted and ripened up nicely for eating.

The packages used for pears vary widely in different parts of the country. As before mentioned, the half-bushel peach basket is very commonly used in handling the crop for delivery to canneries in Maryland, Delaware, and New Jersey. This basket usually goes under the name of the five-eighths basket. Very few of the models, however, hold five-eighths of a bushel. This basket with a slatted cover is also very largely used in shipping by steamer and otherwise to Baltimore and Philadelphia. It is in some respects the least desirable package of all except in cases where the grower can haul the fruit direct to the city markets, or where cars can be filled by packing the entire car tightly with the baskets. The pear box, usually with a middle partition and holding from 3 pecks to a bushel, is very commonly used in the Eastern States. Some very rough specimens of this type of package, made of undressed laths with wide spaces between, annually reach the markets of our Eastern cities, and as the package commonly sells the fruit, low prices may always be guaranteed for such a package, regardless of its contents. On the other hand, the pear box on this model made of neatly dressed half-inch pine or similar wood, can be made really a fancy package, and if the fruit is wrapped in paper, and carefully sorted and packed, it may bring the best prices in the market. In New York State and New England bushel kegs are very largely used for shipping Bartlett, Anjou, and other pears. A still larger package is the pear barrel, a special barrel made for shipping pears, smaller and with less bulge than the apple barrel, and holding about 2¼ bushels. Kieffer pears, and very commonly the Southern Le Conte pears, are frequently shipped in regular apple barrels.

If the grower ships to a commission house, it will be wise to consult the commission merchant as to the form of package which suits the market demands of his city for the different grades and varieties of his fruit. It is very often wise to put up the fancy fruit in a fancy and perhaps small package and to put the poorer grades into larger and cheaper packages. Usually nothing is gained by deception in packing the fruit, especially if the grower expects to use the same market repeatedly and to sell to the same consumers. It is usually best to have a distinct brand or trade-mark if any considerable quantity is to be sold. If the fruit is really meritorious, grocerymen and other fruit buyers will quickly become familiar with this mark and will come back and call for it again. Fruit which is known by a brand will often sell readily and quickly for 50 per cent more than other fruit equally as good, but not known to be so by the buyer.

# OBJECTS AND METHODS OF INVESTIGATING CERTAIN PHYSICAL PROPERTIES OF SOILS.

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## INTRODUCTION.

The physical properties of soils are recognized by plant physiologists to be of the greatest importance in plant economy. Even in the consideration of climatic conditions, it is now generally considered that for most economic plants the meteorological conditions of the soil hold equal rank with atmospheric conditions. A high temperature in the soil under favorable conditions promotes extensive root development; a high atmospheric temperature under equally favorable conditions favors a heavy growth of foliage. A deficiency in water content of either air or soil is attended with distress on the part of the plant. Finally, the leafy portion of the plant and the root system have been shown to be correlated in so many other ways that even without the experimental proofs mentioned above the great influence of soil conditions becomes at once apparent.

The peculiar characteristics displayed by many soils in their relation to plant life can thus be traced, in many instances, directly to certain physical properties of the soil. In the term "physical properties" as applied to soils, we here include also those properties which, in the case of the atmosphere above the soil, are commonly separated into a group known as "climatic conditions." In this broader definition we thus include the two more important soil conditions influenced by climate, namely, the temperature and the moisture content.

In considering the physical characteristics of the soil we must include also the soil atmosphere. By this term we designate the gases contained in the interstitial spaces of the soil, which are thus more or less separated from and to some extent independent of the atmosphere above. This soil atmosphere, particularly when inclosed to some extent by soil moisture, has been shown by King to be capable of modifying somewhat through barometric or temperature changes the distribution of water in the soil.

We thus see that, from a physical standpoint, the soil under field conditions may be divided into three parts, as follows: (1) The soil proper, consisting of the soil grains of various sizes, grouped in different ways and made up of insoluble or difficultly soluble minerals; (2)

the soil moisture, covering the soil grains, and containing in solution a varying amount of the soluble soil constituents; and, (3) the soil atmosphere, differing from air in composition to some extent, and usually saturated with water vapor.

## PHYSICAL PROPERTIES PECULIAR TO THE SOIL GRAINS.

### SOIL TEXTURE.

The two more important physical properties of a soil considered from the standpoint of the first class are texture and structure. Following previous usage of these words, we shall define "texture" to represent the relative sizes of the soil grains, while "structure" will be taken to represent the arrangement of these grains under field conditions. These terms at the present time have only a relative meaning, that is to say, there is no fixed scale for measuring or expressing either texture or structure, such as we have for temperature. In the case of structure we can at present only say that one soil has a closer or a more open structure than another. In a similar manner we say that one soil has a finer texture than another. A more specific statement of texture can, however, be made by the use of the results obtained by mechanical analysis.

The mechanical analysis of a soil consists in separating the soil grains into groups according to size, and in determining the relative amounts of the different groups, which together constitute the soil. Such an examination gives the most reliable means at present available for the comparison and classification of soils, since it is practically free from personal bias and errors of judgment.

In some cases a mechanical analysis fails to give proper indication of important and distinctive characteristics, since it deals only with the size of the grains and not with their arrangement or other physical properties. Beyond question, however, plant development is greatly influenced by the texture of the soil. Whether the texture has a direct influence or whether the effect is due entirely to the change in the water content and other physical properties is not definitely known, and for the present is of secondary importance. The unmistakable relation between the texture of the soil and the character of the crop grown is the important point. This relation makes possible the classification and mapping of soils and the correlation of soils of widely separated areas.[1]

The great importance of a thorough knowledge of the texture of soils is well illustrated in the recent work of the Department relating to the growing of tobacco in the Connecticut Valley. It was observed

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[1] Striking examples of the relation between the texture of the soil and the character of the product may be found in "Tobacco soils of the United States," by Prof. Milton Whitney, Bulletin No. 11, Division of Soils, 1897.

by Professor Whitney that certain soil areas of the Connecticut Valley were practically identical as regards texture and water content with certain areas in Florida upon which the finest of cigar wrappers are being grown from Sumatra seed. Experiments were accordingly made on one of the Connecticut areas, using the same seed and methods of cultivation and curing employed in Florida, with the most satisfactory results. Should the more extensive experiments now in progress support the earlier work, as there is every reason to expect, the result will be to increase greatly the area adapted to the growing of the finest quality of cigar wrappers known, and there will be grown in this country tobacco now imported to the amount of $6,000,000 annually.

This case serves also to emphasize the necessity and importance of surveying important agricultural areas and mapping the various types of soils found, since it is evident that the profitable production of some specialized crop on a given type of soil can be satisfactorily extended to other similar areas only when the location and boundaries of these areas are accurately known.

### MECHANICAL ANALYSIS OF SOILS.

CENTRIFUGAL METHOD.—The mechanical analysis of soils is carried on in this laboratory by what may be called the centrifugal method. Five grams of oven-dried soil, previously passed through a 2-millimeter sieve, are shaken for several hours with about 200 cubic centimeters of water until the sand grains are free from clay. The sample is then transferred to a centrifugal machine of the form illustrated in Pl. XLVII, *3*, and the larger soil grains are thrown down by centrifugal motion to the bottom of the tube, leaving the clay in suspension in the water. The "clay water" is then carefully decanted, the material at the bottom of the tube brought in suspension once more by a jet of distilled water under pressure, and the process repeated until all the clay is removed. This is determined by examining the residue in the tube microscopically, using an eyepiece micrometer, for particles belonging to the clay group.

The apparatus shown in Pl. XLVII, *3*, is arranged for analyzing eight samples of soil at one time, one sample in each tube. The centrifugal framework is suspended from the axis of a one-eighth horse-power electric motor, which is provided with a rheostat for securing different speeds and a reversing switch for stopping quickly.

It is not necessary to use the centrifugal apparatus for the purpose of separating the "silt" group, since the sands settle quite rapidly, leaving the silts alone suspended in the water, which is then decanted as before. The material remaining in the tubes constitutes the sands, which are dried, and then properly graded by means of sieves and bolting cloth.

The "clay" and "silt" groups, which are still in contact with the water with which the separations were made, are evaporated to dryness in metal dishes on a dry plate, then transferred to small platinum dishes, and ignited to remove organic matter. Since during the ignition any calcium and magnesium carbonates present are reduced to oxides, it is necessary to convert the oxides into carbonates again before weighing. This is done by treating for two hours the samples in the presence of water with carbon dioxide under a pressure of about 50 pounds per square inch. The separations are again evaporated to dryness, heated to 110° C., and finally weighed.

The amount of organic matter could be determined indirectly from the original weight of the sample minus the combined weights of all the separations. To check the accuracy of the work, however, a direct determination of the loss on ignition is made on another 5-gram sample, which is ignited and treated with carbon dioxide as before; or the separations may be weighed before ignition and after ignition and treatment with carbon dioxide, the sum of the losses representing the organic matter in the sample used.

The manner in which the soil grains are grouped, together with their conventional names, is given in the following form. All of these separations are used directly as a basis for the classification of soils.

| | Diameter (millimeters). | Conventional names. | Per cent. |
|---|---|---|---|
| (1) | 2—1 | Fine gravel | |
| (2) | 1—0.5 | Coarse sand | |
| (3) | 0.5—0.25 | Medium sand | |
| (4) | 0.25—0.1 | Fine sand | |
| (5) | 0.1—0.05 | Very fine sand | |
| (6) | 0.05—0.005 | Silt | |
| (7) | 0.005—0.000 | Clay | |
| (8) | Soluble salts | | |
| (9) | Loss on ignition | | |
| | Total | | |

In case a soil contains gravel (grains larger than 2 millimeters in diameter), the percentage amount of the coarser material is determined by a sieve separation on a large sample of 500 grams or more.[1]

EARLIER METHODS OF MECHANICAL ANALYSIS.—Two early methods of mechanical analysis deserve notice. Osborne's method is similar in many respects to the one outlined above, the principal difference being that Osborne depended solely upon sedimentation for the separation of his groups, which required a great amount of time and extended

[1] For a more detailed account of the centrifugal method of mechanical analysis, see "Some necessary modifications in the methods of mechanical analysis as applied to alkali soils," by Lyman J. Briggs, Report 64, U. S. Department of Agriculture, 1900.

the examination over a period of a week or more. Analysis of eight or ten samples could, of course, be carried on together.

Hilgard's method operates on the principle that a stream of water moving vertically upward through a tube will suspend and carry off soil particles below a certain diameter, depending on the velocity of the water. By thus regulating the velocity of the stream, the various separations desired may be effected. Each separation is, of course, associated with the total amount of water required to effect the separation, which is necessarily very great. However, with the exception of the finest particles, the separation can be confined to a com-

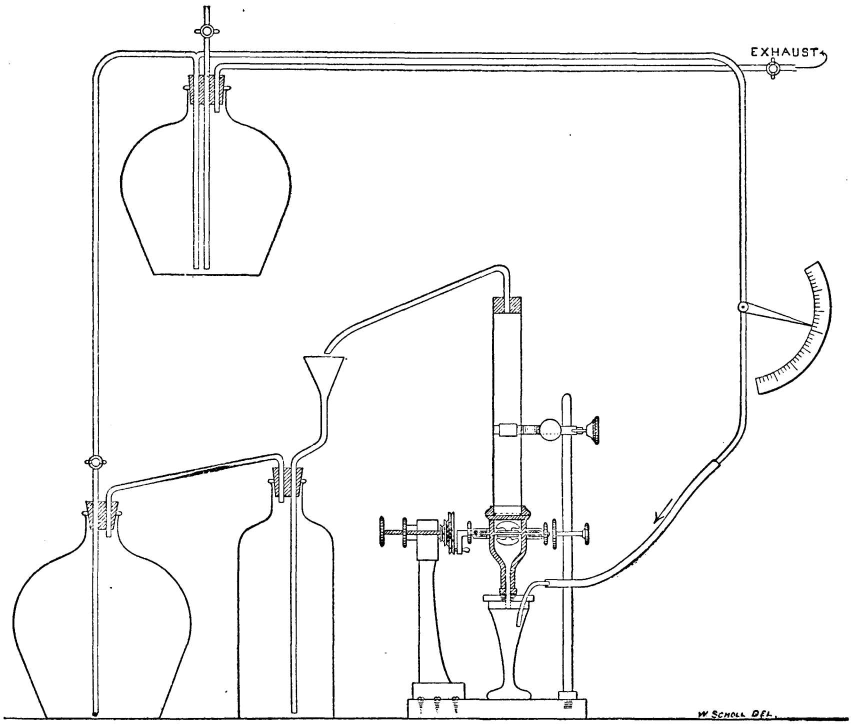



FIG. 46.—Hilgard's "electriator," used in the mechanical analysis of soils.

paratively small volume of water by the simple expedient of bringing the water carrying the separation into a vessel of large horizontal cross section, so that the velocity will be much lessened and the separation will sink to the bottom of the vessel. An arrangement for this purpose is shown in fig. 46, provision being also made for the return of the clear water to the feeding reservoir for a second cycle.

The mechanical analysis of soils by persons unfamiliar with laboratory work can not be recommended. Unless exceptional facilities are available, the results would not justify the time and labor involved. In fact, even in the hands of one accustomed to such determinations, a mechanical analysis is of value chiefly as a guide in comparison, that is to say, the analyst interprets the soil in question in terms of other soils which show a similar texture, the physical properties and producing qualities of which are known.

### SOIL STRUCTURE.

"Structure," as previously indicated, is a term used in soil physics to describe the arrangement of the soil grains. The conception is a somewhat vague one, since we have to deal in practice not with soil particles of any definite shape and size, but with particles in greatly varied forms and sizes, and consequently capable of innumerable configurations or arrangements. Some conception of what is meant by a change in structure may be gained by imagining the arrangement of the grains to be so changed as to change the mean size of the interstitial spaces. The subject is of great importance, but has not as yet been successfully attacked. About the only method available at present for investigating structure is the indirect one of determining the relative rates of flow of air or water through the interstitial spaces of the soil. This method answers fairly well when we are always dealing with the same soil; it fails completely when we attempt to compare two soils, on account of the difference in the texture.

### WATER CONTENT OF SOILS.

The absolute dependence of economic plants upon a proper supply of soil moisture is a matter of common observation. In regions where the water supply is scanty or erratic, the proper conservation of the soil moisture becomes a problem of the greatest importance. This fact has led many soil investigators to make more or less elaborate investigations of the conditions favorable to moisture conservation. Another important branch of the subject is the determination of the normal water content of soil types, which has already been mentioned in connection with the investigations on tobacco soils, as being one of the methods of recognizing similar soil formations. In all experiments of this kind it is of course necessary to determine from time to time the amount of moisture present in the soil.

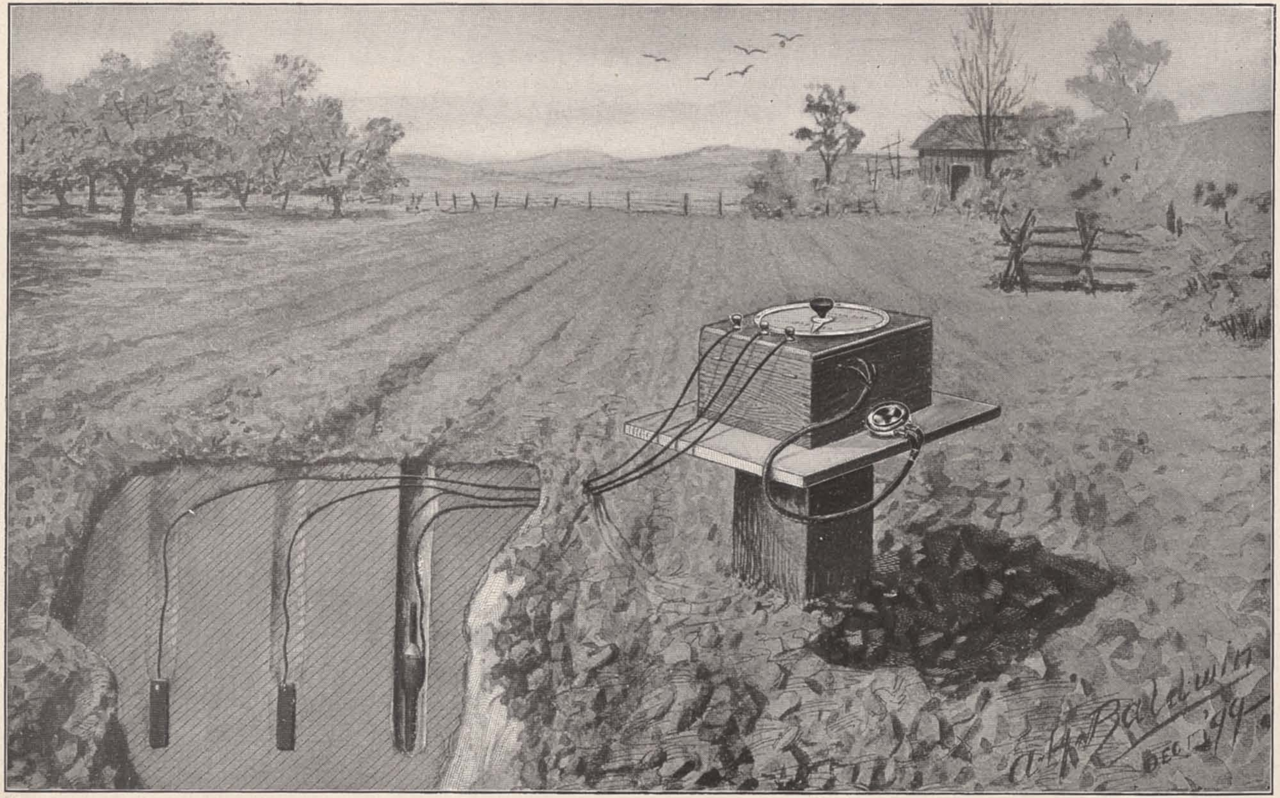
### GRAVIMETRIC METHOD OF MOISTURE DETERMINATION.

The water content of the soil may be determined in two radically different ways. The simpler method, and the one best adapted to a few determinations, may be called the gravimetric method. It consists simply in determining the weight of the moist sample, then drying it at 180° C., weighing it again, and computing the loss in weight, which represents the water, as a percentage of the weight of the dry soil. This method is simple and direct, and can easily be carried out by anyone possessing scales capable of weighing to 1 part in 200


APPARATUS FOR INVESTIGATING PHYSICAL PROPERTIES OF SOILS.

[*1*, Interior of soil hygrometer, used in investigating the water content of soils in the field; *2*, electrical apparatus, used in determining the soluble salt content of soils and irrigation waters; *3*, centrifugal apparatus, used in the mechanical analysis of soils.]

Yearbook U. S. Dept. of Agriculture, 1900.



SOIL HYGROMETER AS USED IN THE FIELD, WITH SECTIONAL VIEW OF THE SOIL, TO SHOW CARBON ELECTRODES AND TEMPERATURE CELL.

with a load of 100 or 200 grams. The only precautions to be observed are: (1) Prevent evaporation as much as possible before weighing; (2) dry thoroughly; and, (3) prevent the dry sample from taking up moisture from the air before the final weighing.

### ELECTRICAL METHOD OF SOIL MOISTURE DETERMINATION.

When a large number of moisture determinations have to be made in connection with field experiments, the labor involved is very great. In such cases the electrical method devised in the Division of Soils is of service. This method depends upon the principle that the resistance offered to the passage of an electric current from one carbon plate to another buried in the soil depends upon the amount of moisture present in the soil between the carbon plates or electrodes. This resistance is measured by means of a suitable instrument designed for this purpose, which is shown in Pl. XLVII, *1*.

The electrical resistance of the soil between the carbon electrodes depends not only upon the amount of water present in the soil, but also upon the quantity of soluble salts dissolved in the water, and upon the temperature. For soils in which the amount of water-soluble material is not sufficiently great to interfere with plant development, field experiments appear to show that for any given water content the amount of salts in solution remains very approximately the same in any given soil. The determinations made by this method rest consequently upon the assumption that the salt content does not change independently of the moisture content. Wherever we have a translocation of salts, due to excessive evaporation or seepage, this assumption will not hold. In such cases the fact that a translocation of salts has taken place is shown by gravimetric moisture determinations, which should be occasionally made for this purpose; and if the departure from previous conditions is not great, the error may be easily corrected.

The effect of the change in the soil resistance due to temperature is eliminated by comparing the soil resistance with the resistance of a small cell containing a solution whose electrical resistance changes with temperature at exactly the same rate as the soil resistance, and which is buried in the soil near the electrodes so as to possess always the same temperature as the soil.

The comparison of these resistances is made by the instrument shown in Pl. XLVII, *1*, which is a modified form of the well-known Wheatstone bridge method of measuring electrical resistance. The soil resistance and the temperature-cell resistance occupy adjacent arms of the bridge, and any change in temperature affects both resistances to the same extent, and so does not disturb the reading of the instrument.

In Pl. XLVIII is shown the instrument as used in the field. A sectional view of the soil is also shown, with the carbon electrodes and temperature cell in place. Electrodes in distant plats may be connected with the instrument by means of overhead wires, so that all the measurements may, if desired, be made from some convenient central point.

The carbon electrodes and temperature cell may be buried in the soil at the beginning of the season and remain undisturbed throughout the year. The moisture record obtained consequently deals with the variation in moisture content of the same portion of soil. This is one of the advantages of the method, since it has been shown that the moisture content of a seemingly uniform soil may vary as much as 4 per cent within an area of one square rod. Consequently, in order to obtain a consistent record of the change in water content, it is necessary to deal with the same sample of soil, which can only be done by this electrical method. Concordant results may of course be obtained by the gravimetric method, if the average of a sufficiently large number of samples is taken, but this involves a corresponding increase in the amount of work required.

A standardization or careful determination of the water content of the soil is necessary at the time the first reading of the instrument is made, in order to determine the relation between the instrument readings and the actual water content. The scale of the instrument is arranged on a decimal plan; so that when the relation mentioned above is once determined, the water content of the soil at any future time can be determined directly from the scale of the instrument, requiring only a slight mental calculation. The standardizations should be repeated from time to time in order to be sure that no change in the salt content has taken place.

We thus see that the electrical method has the advantage of working always with the same portion of soil and furnishes a direct and rapid method of determining the water content after having once been installed. It has the disadvantage of a liability to error in soils where a translocation of salts is apt to occur, and the cost of the instrument and the time involved in the installation and standardization would not justify its use when a few or only occasional determinations are required.[1]

## TEMPERATURE OF SOILS.

The temperature of soils is another physical property that admits of exact measurement. The economic importance of such measurements

[1] For a more detailed account of this method and the construction and operation of the instrument, see "Electrical instruments for determining the moisture, temperature, and soluble salt content of soils," by Lyman J. Briggs, Bulletin No. 15, Division of Soils, 1899. An extensive application of this method to the investigation of the water content of soils will be found in an article by Hays and Smith, Bulletin No. 68, Minn. Expt. Sta., 1900.

is not, however, very great, since the temperature of soils under field conditions is not to any great extent under our control. Temperature investigations have shown that we can to some extent increase the warmth of the soil in the early spring by thorough drainage, since a part of the water is in this way removed and the amount of material which must be heated is lessened, and loss of heat due to surface evaporation is also decreased. The temperature of soils in midsummer can also be somewhat reduced by an efficient dust mulch, which is not a good heat conductor. Temperature investigations have also shown that the shade of the foliage serves to reduce the daily fluctuation of the soil temperature to a considerable extent, by protecting it from the direct rays of the sun and also by cutting down the heat lost at night.

### USE OF MERCURY THERMOMETERS.

Certain forms of mercury thermometers may be successfully used for measuring soil temperatures for short distances below the surface. The precaution must be taken to make the support of the thermometer of wood or other nonconducting material, otherwise the temperature of the thermometer bulb will be raised by conduction. The most important advances in this branch of thermometry are due to the investigations of Whitney and Marvin.[1] Mercury thermometers are not, however, well adapted for determining subsoil temperatures, and for surface work the stem of the thermometer is frequently in the way of tools and consequently liable to damage.

### ELECTRICAL THERMOMETER AND ITS USES.

The objections are overcome in the electrical resistance thermometer, which depends for its operation upon the principle that the electrical resistance of a pure metal is a function of the temperature. In using this instrument a small resistance coil of insulated iron wire inclosed in a leaden sheath is buried in the soil at the desired depth, and connected by insulated wires to the measuring instrument, which may be 50 feet or more away. The resistance of the iron resistance coil, which changes appreciably with change in temperature, is compared by means of the measuring instrument with the resistance of a "manganin" coil, which has a zero temperature coefficient for ordinary temperatures. Consequently, the increase or decrease in resistance of the iron coil may be found, and, knowing the change in resistance per degree, the temperature of the iron coil can at once be determined. For convenience, the instrument is graduated to give the temperature of the coil directly instead of its resistance; so that no calculations whatever are needed, the temperatures being read directly from the scale of the instrument.

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[1] Agrl. Science, Vol. VII, 1893.

This form of thermometer has proved a great convenience in measuring the temperature not only of soils, but also of greenhouses, tanks, and of bulks of tobacco during fermentation. It has the important advantage over any ordinary thermometer that the coil for measuring the temperature can be placed wherever desired, no matter how inaccessible the location might be to an ordinary thermometer, while the measuring instrument may be put in the office or any convenient place. Any number of coils may be read by one instrument, a change of a single connection being all that is necessary for reading each coil.[1]

## ELECTRICAL METHOD OF DETERMINING SOLUBLE SALTS IN SOILS AND IRRIGATION WATERS.

The soluble salt content of a soil is a chemical rather than a physical property of soils, but since a physical method of determining the salt content is also employed in the Division of Soils, a consideration of this method will be in place.

The importance of investigations on the soluble salt content of soils and irrigation waters needs no emphasis with those who are familiar with conditions in the western part of the United States. The abundance of soluble material in the soil in many Western areas demands the greatest care in the use of water, otherwise the soluble constituents of the soil will collect in the lower lands through the seepage waters or else move upward into the surface soil through excessive evaporation, in either case injuring or even entirely preventing plant development.

Timely examinations have frequently resulted in the preservation of valuable tracts of irrigated land which would otherwise have inevitably been ruined by the methods of irrigation in vogue. Many cases of this kind could be cited, and they are indeed striking illustrations of the great economic importance of soil investigations. The remedial measures employed depend, of course, upon the existing conditions, but the solution of the problem in general is the use of underdrainage to prevent the water table from coming too near the surface, and the avoidance of irrigation water containing a dangerous amount of soluble salts.

It is highly important, therefore, to determine in such cases the amount and location of soluble material present in the soil, whether these soluble salts are being transported to or from any other soil, and whether the irrigation water applied carries sufficient material in solution to prevent ultimately the growth of economic plants.

[1] This instrument will be found fully described in Bulletin No. 15, Division of Soils, 1899, entitled "Electrical instruments for determining the moisture, temperature, and soluble salt content of soils."

These questions may all be answered by the determination of the soluble salt content of properly chosen samples from different portions of the area and at various depths below the surface. This determination may of course be made by chemical methods, but a much more rapid method is available when the total amount of salts only is required. We have seen in the discussion of the electrical method of moisture determination that the electrical resistance of the soil depends principally upon three things—moisture, salt content, and temperature. It is therefore evident that, if we can keep constant the moisture content and the temperature of a series of soil samples, we can determine their relative salt contents from their electrical resistances.

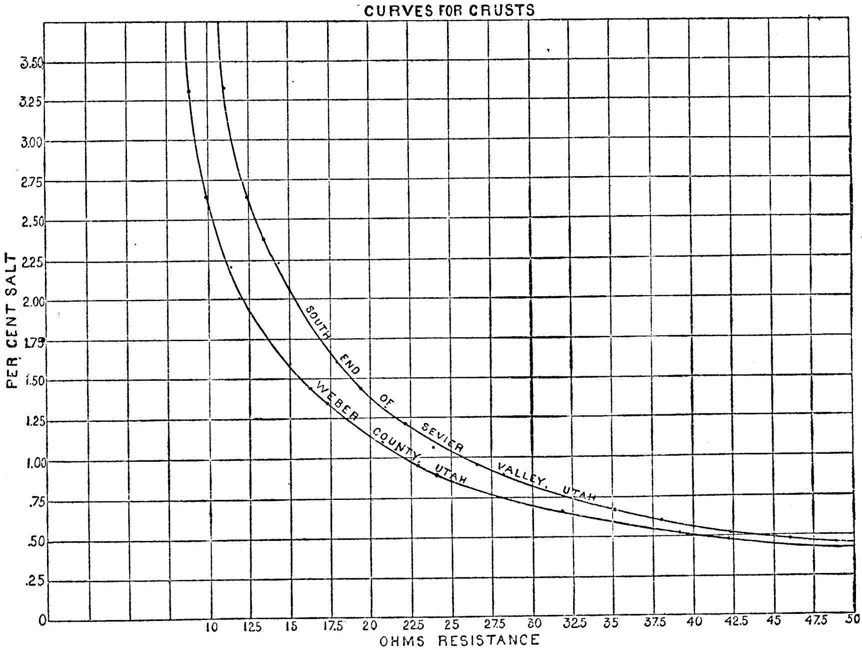


FIG. 47.—Resistance-concentration curves used in determining the amount of salt in soils and irrigation waters.

This constitutes the basis of the electrical method of determining the salt content.

It is more convenient in actual field work to determine the variation in moisture and temperature than to attempt to maintain them constant. In actual practice therefore the temperature and moisture content are noted, and the observed electrical resistance is afterwards reduced to uniform moisture and temperature conditions from data obtained by laboratory determinations.

The resistance of the sample is measured in the field by means of the apparatus shown in Pl. XLVII, *2*. Distilled water is slowly added to the sample under investigation until it is saturated, that is, until free water begins to appear. The saturated soil is then packed with a spatula into the small cell supported at the end of the instrument, the soil being struck off level with the top. This cell is made of hard rubber with two metal sides, and the instrument measures the resistance offered to the current in passing through the saturated soil from one metal plate to the other.

To interpret the field results an interpolation concentration-resistance curve is prepared in the following way: A quantity of soil or soil crusts, representative of the soils under examination as far as the composition of the soluble salts is concerned, is leached with water and the seepage solution evaporated to dryness. From the solid salts thus obtained a series of solutions of different known concentrations is prepared. The resistance of each solution is determined, and from these data a resistance-concentration curve is made. In fig. 47 are shown two curves obtained as described, the ordinates being the resistance of the solution in ohms, measured in the cell actually used in the field, while the abscissæ give the total solids in 100 parts of water. These curves were prepared in the field by Mr. F. D. Gardner, of the Division of Soils, for the purpose of reducing his field observations in the two regions indicated in the diagram. The difference in the position of the two curves in the diagram shows the necessity for determining the curve for each region investigated.

In reducing the observed resistances obtained in the field we compute what the resistance would be if the cell were completely filled with the soil solution alone, the soil grains being removed. This can be readily determined if we know the weight of dry soil contained in the cell and the amount of water required to saturate it, both being definite laboratory determinations which have already been made for different soil types, and which apply to all the salt determinations in soils of any one type.

We now trace along on the diagram the vertical line corresponding to this resistance until it intersects the curve; and then tracing the horizontal line passing through the point of intersection until it meets the axis we can at once read off the concentration of the solution. A simple calculation suffices to give, if desired, the weight of salt in unit weight of soil. In the case of irrigation waters the process is similar, though more simple. A quantity of water is evaporated to dryness and from a known weight of soluble salts thus obtained a series of solutions of known concentration is prepared, from which a curve is constructed as before. A comparison of the observed resistance of the irrigation water at any time with the curve gives at once the amount of soluble salts present. In all cases the resistance must of course be reduced to the temperature for which the curve was constructed, which is readily done from tables.

It will at once be seen that if a number of determinations are to be made, this method, depending upon the electrical resistance of the solution, is much more rapid than any chemical method for the determination of the total soluble salts. Two men can, by using this method, take from 60 to 100 samples of soil and determine the salt content of each in a working day. This method does not of course tell us the composition of the salts, for which we are dependent on chemical methods; but it does give at once the total amount of soluble salts present, with an accuracy amply sufficient for field work.[1]

### OTHER PHYSICAL PROPERTIES OF SOILS.

Space forbids more than a passing mention of certain other physical properties of soils which are of great interest and importance. The flocculation of clay particles has a direct bearing upon the tilth of a soil, as well as upon the rate of the capillary movement of water, and a knowledge of the conditions governing flocculation is consequently of direct economic importance. Carbonate of lime, gypsum, and certain other salts, especially the alums, are particularly active in flocculating the clay. This is undoubtedly one reason why the application of lime is beneficial to some heavy soils, since the aggregates formed possess many of the characteristics of a solid particle of the same diameter, and the soil in drying presents a loose crumbly structure. Ammonia and sodium carbonate or "black alkali," on the other hand, break down any aggregates which have been formed, and thus have the effect of "puddling" the soil, which dries into a hard compact mass. Concentrated solutions of all salts, however, produce more or less flocculation. Aside from the action of salts, comparatively little is known regarding the conditions controlling flocculation, and the subject deserves thorough investigation.

Finely divided solids, such as for example the minerals constituting the soil, when brought into contact with a solution, have the property of removing a portion of the dissolved substance from solution and concentrating it upon the surface of the solid. This phenomenon is known as adsorption, and is undoubtedly of great importance from an economic standpoint, since it helps to retain the soluble plant food in the soil which would otherwise be soon carried away in the drainage waters. The concentration of the solution immediately at the surface of the solid is, so to speak, much greater than in other portions of the solution, and the adsorbed portion of the dissolved substance is not free to move like the remainder. Thin films of carbon dioxide and other gases with which the soil is in contact are also condensed on the surface of the soil grains in a manner very similar to substances in solution.

The adsorbed portions of the dissolved substance is, of course, in equilibrium with the solution, and the amount adsorbed consequently

[1] A more complete description of this instrument and its operation may be found in Bulletin No. 15, Division of Soils, 1899.

varies with concentration and the temperature. These relations are of much importance, and are now being investigated, together with the relative adsorption of different salts.

The translocation of salts and the capillary movement of water[1] constitute other important soil problems, regarding which we have considerable experimental knowledge, but which, like those already discussed, must be more completely investigated before many of the great field problems that are daily presented can be completely solved.

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[1] A discussion of this last-named subject by the writer will be found in "The mechanics of soil moisture," Bulletin No. 10, Division of Soils, 1898. A less technical discussion may also be found in an article in the Yearbook for 1898 on "The movement and retention of water in soils."

# THE FOOD OF NESTLING BIRDS.

By Sylvester D. Judd, Ph. D.,
*Assistant Biologist, Biological Survey.*

## GENERAL REMARKS.

The amount of food consumed by nestling birds is not generally appreciated. The number of broods and of young vary according to the species and the region under consideration, but it is safe to say that on the average 2 or 3 broods of 3 to 5 each are raised every season. The young, from the time the eggs are hatched until the last offspring has left the nest, demand the most constant and untiring industry on the part of the parents. The labor of feeding begins before sunrise and continues with little rest until after sunset. Meals are very frequent, often averaging one every two minutes. At first the nestlings consume more than their own weight of food in a day, and make a daily gain in weight of 20 to 50 per cent. At this time they appear to consist of little else than mouth and stomach, and spend nearly all their waking moments in eating. The total of the material required to satisfy their voracity is astonishingly large. A young robin kept in captivity by Professor Treadwell required 60 earthworms a day,[1] and the young of a pair of European jays, observed by Dr. Brewer, were fed half a million caterpillars in a single season.[2] The character of the food consumed in such quantity by different species of nestlings, apart from its scientific interest, is of great importance to the farmer, since many nests are placed in proximity to growing crops and the nesting season corresponds with the period of greatest agricultural activity.

Species of birds having a homogeneous diet, either animal or vegetable, rear their young upon food similar to that which they themselves take. Thus, gulls, terns, pelicans, herons, kingfishers, and the like piscivorous birds, bring up their broods principally on fish; truly raptorial birds, such as hawks and owls, feed their young on birds and mammals; exclusively insectivorous birds, such as cuckoos and swallows, feed nothing but insects; and exclusively granivorous birds, such as doves and pigeons, feed only starchy seed materials. But

[1] Proc. Boston Soc. Nat. Hist., Vol. VI, pp. 396–399, 1859.

[2] Bulletin Ill. State Laboratory Nat. Hist., Vol. I, No. 3, p. 82, 1880.

birds that subsist on both animal and vegetable matter usually feed their young almost entirely on insects, chiefly such injurious kinds as grasshoppers and cutworms. Many of our common birds are comprised in this class.

Seed-eating birds and those that subsist on a mixed animal and vegetable diet, composed largely of hard material, have powerful muscular grinding gizzards, for food of this kind resists digestion and requires to be broken up in the stomach; but birds which live on insects or vertebrates that are soft and easily digested have thin-walled, comparatively weak, nonmuscular stomachs. These anatomical peculiarities and consequent differences of function must not be lost sight of in the study of the food of young birds, for they are responsible for marked differences of diet as maturity is approached. Whatever may be the character of the parents' stomach structure, however, the stomach of

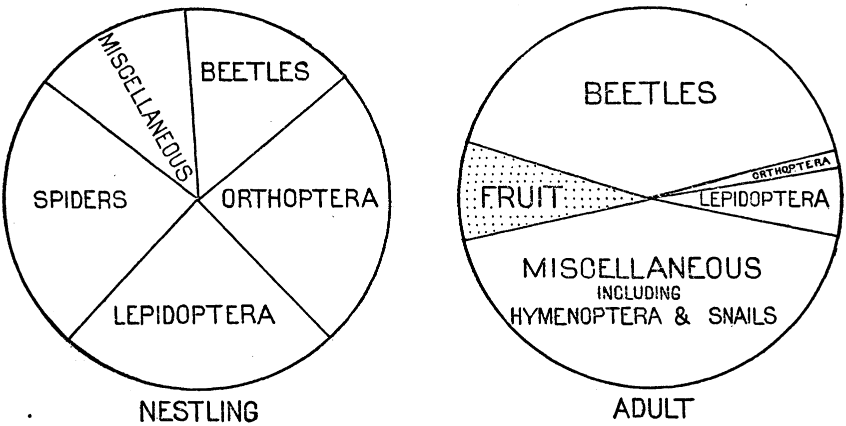


FIG. 48.—Diagram showing proportions of food of bluebird (*Sialia sialis*), young and adult.

a newly hatched nestling is in most cases merely a membranous sac with comparatively little muscular development, and can not assimilate anything but the softest, most readily digestible material. Therefore in the case of many species the food of the young must differ radically from that of the adult. Such grain-eating birds as pigeons, possessed of strong gizzards, feed their squabs on the so-called "pigeon's milk," which is digested grain of semifluid consistency, disgorged by the parent bird into the gullet of its offspring. Many birds that are largely vegetarians, but not endowed with this power of regurgitating digested food, rear their young for a time on insects. The crow blackbird, whose annual food is three-fourths vegetable matter, will serve as an illustration: The first meal of the nestlings often consists of plump spiders of soft texture, which suit the delicate embryonic stomach; and these, together with tiny young grasshopper nymphs and soft small cutworms, continue for a while to form the food. As

FIG. 1.—BLUEBIRD AT EDGE OF NEST WITH GRASSHOPPER IN MOUTH.

[From photograph by Rev. P. B. Peabody.]

FIG. 2.—NESTLING CROWS.

[From photograph by Rev. P. B. Peabody.]

the stomach develops, however, the diet changes; such hard insects as beetles soon become a part of the fare, and by the time the young blackbirds are nearly or quite half grown their stomachs are strong enough to digest corn. Corn is then given to them freely, and in increasing quantity, until, when they are ready to leave the nest, it forms about one-quarter of their food.

In the following study of the food of nestlings of the various kinds of birds each group is taken up separately. The material has been gathered from detailed field observations by the writer and others and from examination of the contents of the stomachs of 700 nestlings.

### BLUEBIRD.

The food of 6 feathered nestling bluebirds (*Sialia sialis*, Pl. XLIX, fig. 1), the stomachs of which were examined in the laboratory, consisted of beetles, caterpillars, grasshoppers, spiders, and a few snails. Adult birds collected during the breeding season had eaten about three times as many beetles and a few ants, while 8 per cent of the food consisted of black raspberries. (Fig. 48.)

### ROBIN.

The robin (*Merula migratoria*) is about as troublesome to the horticulturist as are the catbird and cedar waxwing. Prof. F. E. L. Beal found that young nestlings, watched for several hours, were fed from five to six times an hour. Subsequent examination of the stomachs of 14 of these nestlings and of 8 of their parents showed that raspberries, blackberries, blueberries, cherries, and serviceberries formed only 7 per cent of the food of the young, while it formed 70 per cent of that of the old birds. In the case of the young, many of the stomachs contained pellets of grass, one in each stomach, the significance of which is not yet clear. The insect food of the young consisted chiefly of caterpillars, locusts (Locustidæ), grasshoppers, crickets, and beetles (carabid beetles, May-beetles, and their larvæ). Spiders, snails, and earthworms were present in smaller quantities.

### HOUSE WREN.

The house wren (*Troglodytes aëdon*) is exclusively insectivorous, and is one of the most useful birds on the farm. That nestlings are fed very frequently and consume an enormous quantity of food is well shown by a half day's observation made by the writer at Marshall Hall, Md., on June 17, 1899, of the feeding of a brood of three. The family was found housed in a cavity in a locust tree, and was transferred to a baking-powder can, which was nailed to the trunk of the tree 4 feet above the ground, a convenient height for observation.

The young were about three-fourths grown. The following is a detailed account of the feeding:

*Feeding of a brood of house wrens.*

A. M.

5.55. Green caterpillar (*Heliothis dipsaceus*).
5.56. May-fly.
6.00. May-fly.
6.02. Undetermined.
6.05. *Heliothis dipsaceus.*
(Observations suspended till 7.20 a. m.)
7.21. Undetermined.
7.23. May-fly.
(Observations suspended till 7.45 a. m.)
7.46. Harvest-man (Phalangidæ).
7.47. May-fly.
7.48. Undetermined insect.
7.49. Undetermined.
7.51. Undetermined.
7.55. Undetermined.
7.56. Undetermined.
7.57. Undetermined.
7.57½. Undetermined.
8.00½. Undetermined.
8.01. Undetermined.
8.03. Undetermined.
8.03½. Undetermined.
8.06. *Heliothis dipsaceus.*
8.08. Undetermined insect.
8.11. Undetermined insect.
8.13½. Brown caterpillar.
8.16. Undetermined insect.
8.18. Undetermined insect.
8.20. Undetermined insect.
8.22. Undetermined insect.
8.23. Two May-flies.
8.24. May-fly.
8.29. Brown orthopterous insect.
8.30. *Heliothis dipsaceus.*
8.35. Undetermined.
8.38. Caterpillar.
8.41½. May-fly.
8.43. May-fly.
8.45. Brown caterpillar (cutworm?).
8.46. *Heliothis dipsaceus.*
8.47. Undetermined insect.
8.48. Undetermined insect.
8.49. Undetermined insect.
8.50. Undetermined insect.
8.52½. Cutworm (?).
8.55. *Heliothis dipsaceus.*
8.56. Undetermined insect.

A. M.

8.59. Pentatomid bug (*Nazara?*).
9.03. Cutworm (?).
9.05. Cutworm.
9.10. Caterpillar (*Acronycta oblinita*).
9.13. Brown soldier bug.
9.17. Green caterpillar (noctuid).
9.20. White grub.
9.25. Clay-colored grasshopper.
9.25½. Grasshopper.
9.30. Undetermined insect.
9.37. (Two cabbage worms placed on edge of tin can.)
9.38. *Acronycta oblinita.*
9.39. *Heliothis dipsaceus.* (Refused cabbage worm.)
9.39½. May-fly.
9.45. Grasshopper.
9.46. Cutworm.
9.50. Grasshopper (*Melanoplus*).
9.52. Saw-fly larva (?).
9.54. Miller (noctuid).
9.55. *Heliothis dipsaceus.*
9.57. *Heliothis dipsaceus.*
10.00. Spider.
10.01. *Heliothis dipsaceus.*
10.05. Black chrysalis.
10.08. Cutworm.
10.15. Spider.
10.16. Caterpillar.
10.20. May-fly.
10.23. Spider.
10.26. Clay-colored grasshopper.
10.29. Clay-colored grasshopper nymph.
10.30. *Acronycta oblinita.*
10.35. Green caterpillar.
10.38. *Heliothis dipsaceus.*
10.41. *Heliothis dipsaceus.*
10.46. Clay-colored grasshopper.
10.48. Spider.
10.50. Miller (noctuid).
10.52. Clay-colored grasshopper nymph.
10.54. Miller (noctuid).
11.02. May-fly.
11.02½. May-fly.
11.15. Green caterpillar.
11.20. Miller (noctuid).
11.21. Black chrysalis.
11.22. Saw-fly larva (?).

*Feeding of a brood of house wrens*—Continued.

| | | | |
|---|---|---|---|
| A. M. | | A. M. | |
| 11.25. | Spider. | 11.48. | May-fly. |
| 11.26. | Grasshopper (*Melanoplus*). | 11.50. | Cutworm. |
| 11.30. | *Heliothis dipsaceus.* | 11.51. | *Heliothis dipsaceus* (2). |
| 11.30½. | May-fly. | 11.59. | *Heliothis dipsaceus.* |
| 11.32. | Spider. | 12.02. | *Heliothis dipsaceus.* |
| 11.34. | Grasshopper (*Melanoplus*). | 12.06. | Spider. |
| 11.34½. | Saw-fly larva (?). | 12.07. | *Heliothis dipsaceus.* |
| 11.36. | *Acronycta oblinita.* | 12.09. | Cutworm. |
| 11.39½. | May-fly. | 12.11. | Spider. |
| 11.47. | Cutworm. | | |

The mother wren thus made 110 visits to her little ones in four hours and thirty-seven minutes, and fed them 111 insects and spiders. Among these were identified 1 white grub, 1 soldier bug, 3 millers

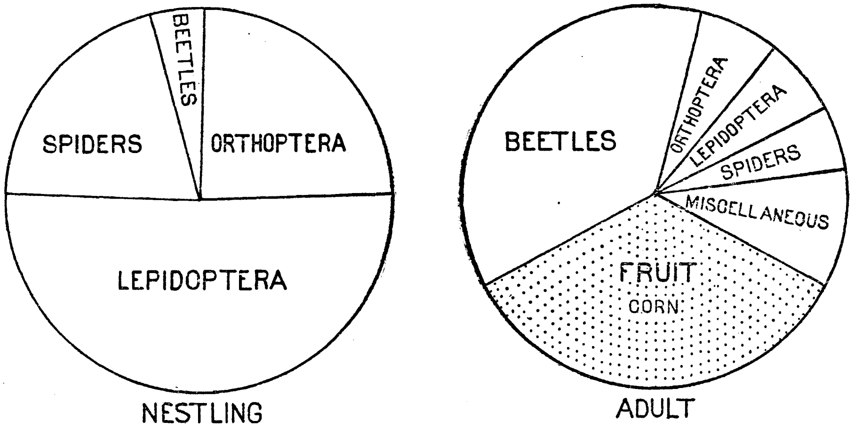


FIG. 49.—Diagram showing proportions of food of brown thrasher (*Harporhynchus rufus*), young and adult.

(Noctuidæ), 9 spiders, 9 grasshoppers, 15 May-flies, and 34 caterpillars. On the following day similar observations were made from 9.35 a. m. till 12.40 p. m., and in the three hours and five minutes the young were fed 67 times. Spiders were identified in 4 instances, grasshoppers in 5, May-flies in 17, and caterpillars in 20. The usual difference between the food of adult birds and that of their young is less marked in the case of the house wren. (Pl. L, fig. 1.)

BROWN THRASHER.

The examination of 6 nestling and 7 adult brown thrashers (*Harporhynchus rufus*) indicates that the adults during the breeding time eat fruit to the extent of one-fourth of their food, while their young, on the other hand, are exclusively insectivorous, subsisting mainly on spiders, grasshoppers, and caterpillars. (Fig. 49.)

### CATBIRD.

The stomachs of 14 young nestlings of the catbird (*Galeoscoptes carolinensis*) and 11 adults, mainly the parents of these young, have been examined in the laboratory. The old birds had taken 91 per cent of their food in fruits—buckthorn, catbriar, cherries, raspberries, and blackberries. The nestlings had eaten fruit to the extent of only 4 per cent of their food, and the remainder of their diet was principally ants, beetles, caterpillars, spiders, and grasshoppers. (Pl. L, fig. 2.)

### MOCKINGBIRD.

The food of the adult mockingbird (*Mimus polyglottos*) is about equally divided between insects and fruit. The late Townend Glover observed that nestlings which he had in captivity were fed by their mother almost entirely on insects, among which were numbers of the moth of the cotton-boll worm, so destructive to the crops of the South.[1]

### WARBLERS.

Warblers are insectivorous, and probably rear their young on a purely animal diet. Little definite observation is available, however; the conclusion is based on general grounds. The stomachs of 3 half-grown nestlings of the oven bird (*Seiurus aurocapillus*) examined in the laboratory contained beetles of the family Lampyridæ, and click-beetles, caterpillars, moths, spiders, and snails; and Mr. Percy Moore reports that he has observed oven birds feeding span-worms (Geometridæ) to their young. Mrs. Irving Bruce writes that she found a nestful of redstarts (*Setophaga ruticilla*), and ascertained that they were fed on insects from 5 to 30 times an hour. These insects were caught by the mother bird on the wing, and often included millers.

### VIREOS.

Prof. F. E. L. Beal found that some nestling red-eyed vireos (*Vireo olivaceus*) 3 days old received food from their parents from 7 to 14 times an hour. Examination of their stomachs showed that they had been fed on tree-hoppers, assassin bugs, spiders, sphinx caterpillars, and butterflies.

### SHRIKE.

Mr. F. H. King has observed a white-rumped shrike (*Lanius ludovicianus excubitorides*) carrying mice and warblers to young nestlings, and has found a recently abandoned shrike's nest literally lined with the wing-covers of useful predaceous tiger-beetles.[2] Six nestlings and 6 adults of the same species of shrike examined in the laboratory had eaten grasshoppers to the extent of 75 per cent of their food. Both old and young birds had taken some beetles, crickets, and spiders.

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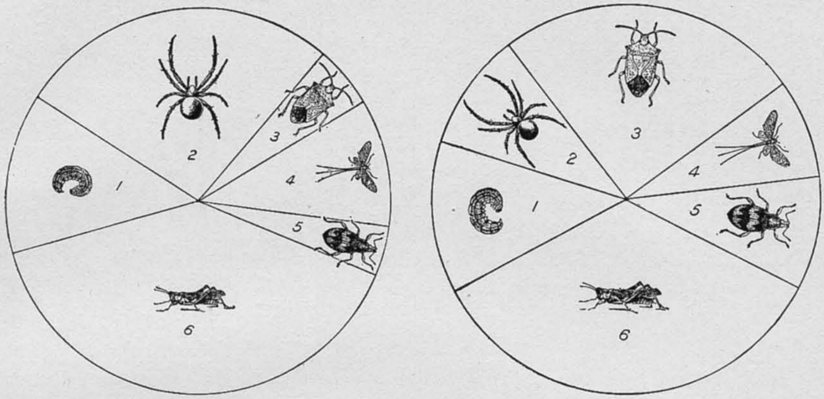
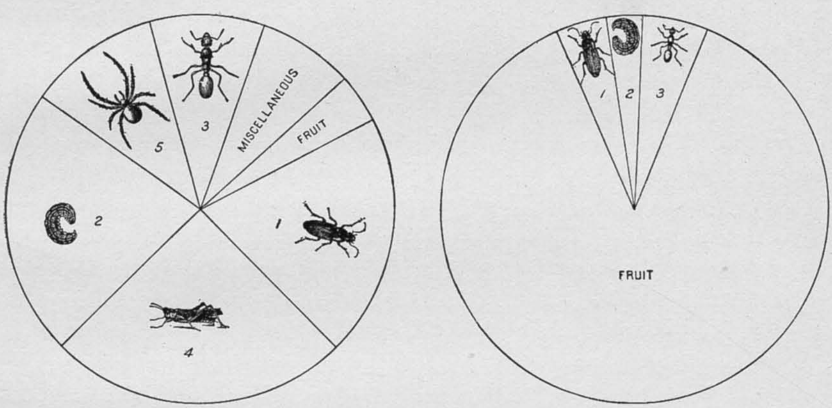
[1] Rept. U. S. Dept. Agriculture for 1865, p. 41, 1866.
[2] Trans. Wis. State Agr. Soc., p. 438, 1886.



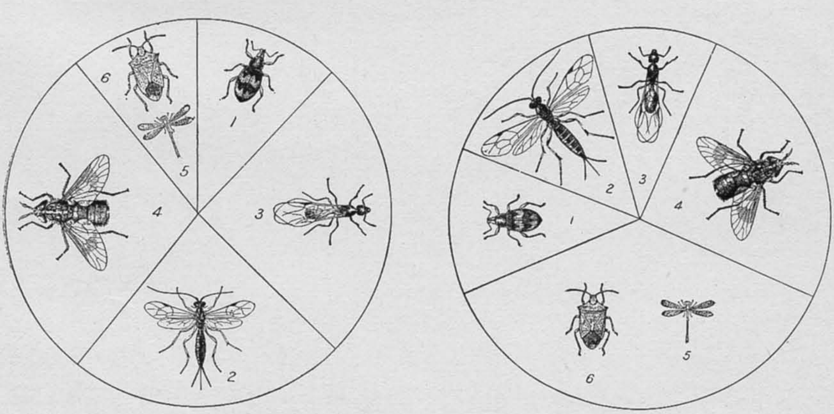

NESTLING. FIG. 1.—HOUSE WREN. ADULT.

[1, Cutworm ; 2, spider ; 3, stink-bug ; 4, May-fly ; 5, weevil ; 6, grasshopper.]




NESTLING. FIG. 2.—CATBIRD. ADULT.

[1, Ground-beetle ; 2, cutworm ; 3, ant ; 4, grasshopper ; 5, spider.]




NESTLING. FIG. 3.—BANK SWALLOW. ADULT.

[1, Weevil ; 2, ichneumon-fly ; 3, winged ant ; 4, fly ; 5, dragon-fly ; 6, stink-bug.]

## FOOD OF NESTLINGS AND ADULTS OF SOME COMMON BIRDS.

[The diagrams show the proportions of the various orders of insects in the food, each order being represented by the insect belonging to it that is most commonly eaten by the bird whose food is shown. (In the case of the Hymenoptera a division is sometimes made between the parasitic members of the order, which are very useful, and those that are neutral or injurious. The figures of insects are reduced from cuts kindly loaned by Dr. L. O. Howard.)]

Two of the young had eaten parts of mice, but the adults had fed solely on insects. (Fig. 50.)

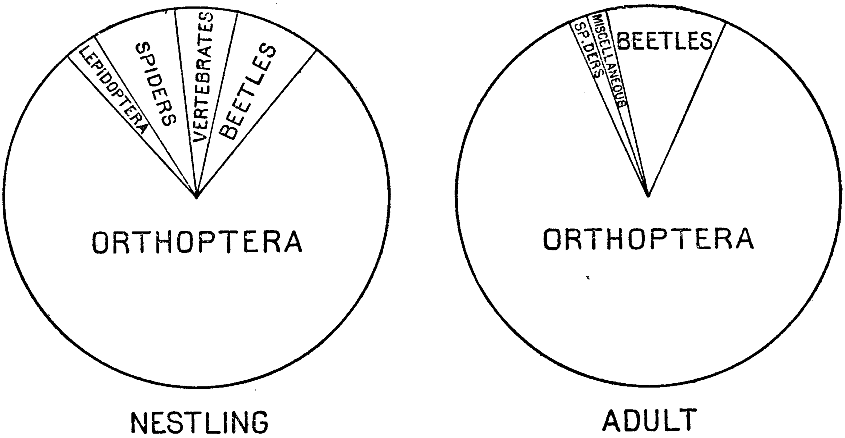



FIG. 50.—Diagram showing proportions of food of white-rumped shrike (*Lanius ludovicianus excubitorides*), young and adult.

### CEDAR WAXWING.

Mr. Frank Bolles, in speaking of his studies of cedar waxwings (*Ampelis cedrorum*), says:

I imprisoned the cedarbirds [nearly fledged nestlings] on July 10. * * * It was only a short time before the parent birds began consoling the young with [wild] cherries (*Prunus pennsylvanica*). During the 12 days of their captivity the young were supplied with 8,400 cherries. * * * On an average the old bird or birds made 140 visits a day, bringing five cherries each time. One was carried in the beak, and the others were jerked up from the throat one by one until all of the five young were fed.[1]

In the laboratory, stomach examination showed that a pair of cedar waxwings from a garden in Portland, Conn., had eaten nothing but mulberries, while they fed their 3 nestlings with mulberries and beetles. The beetles—little dung-beetles (*Aphodius*)—amounted to 88 per cent of the food of the young birds.

### SWALLOWS.

Swallows are exclusively insectivorous during the breeding season and rear their young on insects. Mr. Otto Widmann, who has observed the feeding habits of purple martins (*Progne subis*), found that the parent birds carried to their nestlings dragon-flies, butterflies and moths, grasshoppers, beetles, and flies. They made from 100 to 300 visits a day to each nest.[2] Mr. John L. Russell states that a quart of wing-covers of the cucumber beetle (*Diabrotica vittata*) have been taken from the nesting box of a martin.[3]

[1] Auk, Vol. VII, p. 290, 1890.

[2] Forest and Stream, Vol. XXII, p. 484, 1884.

[3] Rept. U. S. Dept. Agriculture for 1864, p. 354, 1865.

The stomachs of 126 nestlings of the barn swallow (*Hirundo erythrogastra*) and bank swallow (*Clivicola riparia*) have been examined, but the food does not differ materially from that of the adults. (See fig. 51 and Pl. L, fig. 3.) Swallows do good service by destroying injurious flies, weevils, and bark beetles (Scolytidæ), and the somewhat harmful species of ants (*Myrmica scabrinodis*, *Lasius niger-alienus*, etc.). Many of the nestlings had been given pieces of oyster or mussel shell from 2 to 5 mm. in diameter, while others had been furnished with fragments of quartz, for what purpose is not apparent, since such material would scarcely be needed to grind up the soft insects eaten by these birds. The lime in the shells may perhaps have some direct physiological use in the nestling's system.

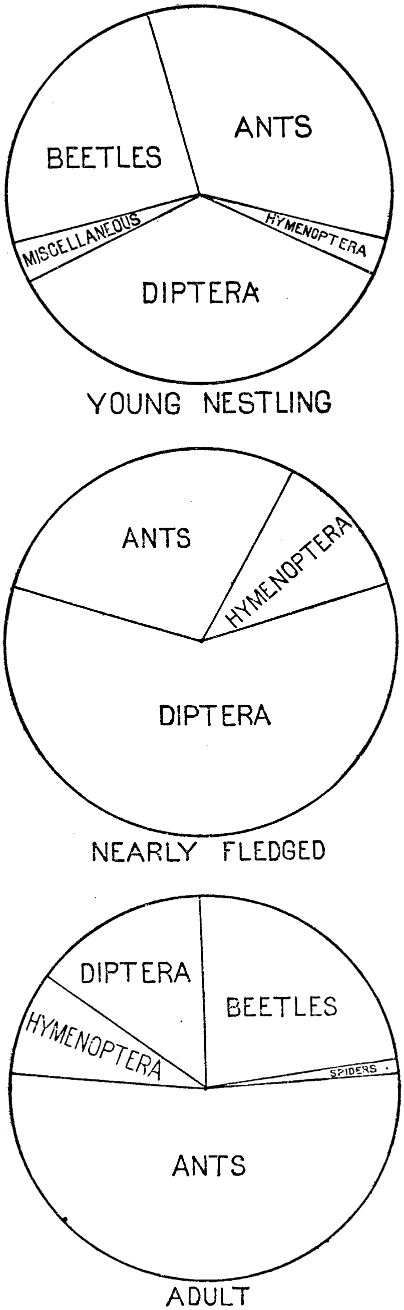



FIG. 51.—Diagram showing proportions of food of barn swallow (*Hirundo erythrogastra*), young and adult.

#### TOWHEES AND GROSBEAKS.

A few facts have been gathered concerning this group of birds. The stomachs of 3 towhees (*Pipilo erythrophthalmus*) 8 days old that were examined in the laboratory contained long-horned beetles, click-beetles, weevils (Rhynchophora), and scarabæids; also crickets, grasshoppers (Acrididæ and Locustidæ), tree-hoppers, soldier bugs, spiders, and snails. Rose-breasted grosbeaks (*Zamelodia ludoviciana*) have been observed by Prof. F. E. L. Beal feeding their newly fledged young in a potato field on potato beetles.

#### TANAGERS.

Adult scarlet tanagers (*Piranga erythromelas*) during the breeding season live mainly on beetles and caterpillars, and also eat cherries, serviceberries, raspberries, blackberries, and other fruits. Three nestlings less than a week old, examined by Mr. F. H. King, had eaten caterpillars, bugs, and grasshoppers.[1]

### SPARROWS.

Native sparrows are granivorous to the extent of two-thirds or more of their diet, but apparently rear their young exclusively on insects. The food of young grasshopper sparrows (*Ammodramus savannarum passerinus*) has been studied by means of stomach examination and some slight field observation. At Marshall Hall, Md., a parent bird was carefully watched as she brought food to her 4 naked young. Three long-horned grasshoppers (*Xiphidium*), 2 species of short-horned grasshoppers (*Melanoplus femur-rubrum* and *Dissosteira carolina*), a chrysalis, and an army worm were identified in the parent's bill. Another grasshopper sparrow in the same field, that was carrying food to its older and feathered young, was shot. In its beak and mouth were 2 bugs (*Alydus pilosulus* and *Hymenarcys nervosa*) and 2 spiders (*Oxyopes salticus*), and in its stomach 2 of the same species of spiders, a bug (*Alydus*), 2 leaf-beetles (1 of which proved to be *Systena elongata*), a weevil, a cutworm, the jaws of a cricket, some seeds of rib grass, and a grain of wheat. In the stomachs of 10 nestlings and 14 adults collected in Kansas, half of the food of the old birds was found to be grass seed, while that of the young consisted entirely of insects—caterpillars, grasshoppers, and a very few spiders. (Pl. LI, fig. 1.)

The feeding habits of young chipping sparrows (*Spizella socialis*) have been investigated by Dr. Clarence M. Weed, of the New Hampshire experiment station, who watched and carefully recorded the feeding of a brood of 3 nearly fledged nestlings in a juniper tree but a few yards from his library window.[2] His observations, which were made in June, 1898, began at 3.40 a. m. and were continued without interruption until 7.50 p. m., when darkness put a stop to further work. The first meal was served to the youngsters at 3.57 in the morning and the last at 7.27 in the evening. Throughout the long day the parent birds kept flying to and from the nest, bringing food and carrying away excrement. The largest number of visits in a single hour was 21 and the total number of visits for the day amounted to nearly 200. The longest rest was one of twenty-seven minutes during the afternoon. Although but few of the smaller objects fed to the nestlings could be identified, the larger forms of insect food were very satisfactorily determined. Most of these appeared to be caterpillars,

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[1] Trans. Wis. State Agr. Soc., pp. 427, 428, 1886.

[2] Bulletin 55, New Hampshire Agr. Expt. Station, 1898.

but some few were crickets, crane-flies, and earthworms. No less than 50 caterpillars were brought to the young during the day. Their specific identity is uncertain, but Dr. Weed states that many of them were probably referable to the family Noctuidæ, and many also to the larvæ of the American copper-hind-wing moth (*Amphipyra pyramidoides*). Some few were larvæ of the hook-tip moths and a few were cabbage worms. Making the moderate assumption that there are 20 broods of chipping sparrows on a farm of average size, and that each requires as many caterpillars as this one observed by Dr. Weed, the number of these pests consumed amounts to a thousand a day. The absence of grasshoppers in Dr. Weed's observations is odd, as these insects often form the most important element of the food of young birds, and grasshoppers and beetles composed the entire food of 3 nestling chipping sparrows about a week old whose stomachs were examined in the laboratory.

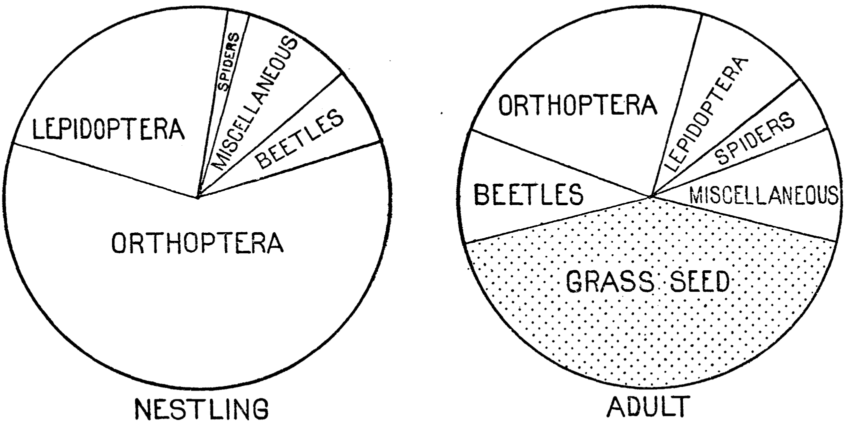


FIG. 52.—Diagram showing proportions of food of dickcissel (*Spiza americana*), young and adult.

Fourteen stomachs of dickcissels (*Spiza americana*) on examination showed that the birds had been fed chiefly on short-horned and long-horned grasshoppers and crickets. Four of the 14 stomachs contained snails, a larger proportion than is found in the stomachs of adults. The destruction of snails is of some slight service, since the pond snail, which is likely to be eaten with the rest, acts as an intermediate host to the liver fluke, the foe of the sheep farmer. (Fig. 52.)

The adult English sparrow (*Passer domesticus*) is almost exclusively vegetarian in diet. It derives less than one-tenth of its food from the animal kingdom. Its nestlings, however, are insectivorous to the extent of more than half of their diet, while grain, principally oats, forms only one-third of their food. The insect food of 65 nestlings, most of them not feathered, collected in rural districts in Maryland and Virginia, consisted principally of grasshoppers, together with a few caterpillars, spiders, and weevils. Cabbage worms and white grubs are sometimes fed to the young, and an occasional earthworm is filched from a robin. Parent birds have often been seen to capture flying insects on the lawns of the Department of Agriculture to feed to their nestlings. The slow-moving May-flies are readily secured, and swift-flying cicadas, when abundant, are captured without much difficulty, owing to their bee-line course. Grasshoppers and moths with their zigzag flight seem more baffling, but are nevertheless often captured on the wing. From April till August weevils and cutworms are taken to the young from the Department lawns. Some interesting observations on the insectivorous habits of young English sparrows by Mr. George H. Berry, of North Livermore, Me., are worth repeating in this connection.[1] In a nest containing 3 young he discovered the remains of 2 large moths, the luna moth (*Tropæa luna*) and the cecropia moth (*Samia cecropia*), a swallow-tailed butterfly (*Papilio turnus*), a mourning-cloak butterfly (*Vanessa antiopa*), and an unbroken specimen of the hairy larva of that pest of shade trees, the tussock moth (*Orgyia leucostigma*). When he placed a stick with plenty of these larvæ near another brood, the parent birds at first paid no attention to them, but subsequently they fed 3 of them to their young. During three hours of observation a pair of sparrows noted by Mr. Berry fed to their nestlings 60 small green worms. Multitudes of insects may be destroyed in this way. One morning, in the vicinity of the Department of Agriculture, thousands of winged white ants (*Termes flavipes*) were noticed by the writer swarming over the sidewalk, and among these insects, picking them up with surprising quickness, were half a dozen adult English sparrows of both sexes. All the birds were frightened away except one female, which continued to snap up ants undisturbedly. She flew with a dozen up to her nest in the gutter of a house, and immediately returned. At the end of five minutes she had made 3 more trips, carrying to the young 41, 71, and 50 in the respective trips; 162 white ants were thus disposed of in five minutes. The systematic manner in which the bird procured her supplies commanded admiration. She picked up insect after insect in rapid succession, swallowed them until her gullet appeared to be full, and then filled her mouth so that a fringe of wings stuck out on each side of her bill. The destruction of white ants is a service, as they have a habit of tunneling into the woodwork of buildings. Injuries occasioned in this way made it necessary in 1896 to remove the wooden floor of one of the largest rooms of the United States National Museum, and replace it with cement.

The feeding habits of young English sparrows of cities are of value, since many of the insects eaten are injurious, while the vegetable food,

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[1] Bulletin 1, Div. Ornith. and Mamm., Dept. Agr., p. 291, 1889.

being composed of waste oats in horse droppings, is of no importance; but in the country the good effect caused by the destruction of insect pests is largely counterbalanced by the fact that much of the vegetable food consists of grain derived from crops. Nestling native sparrows,

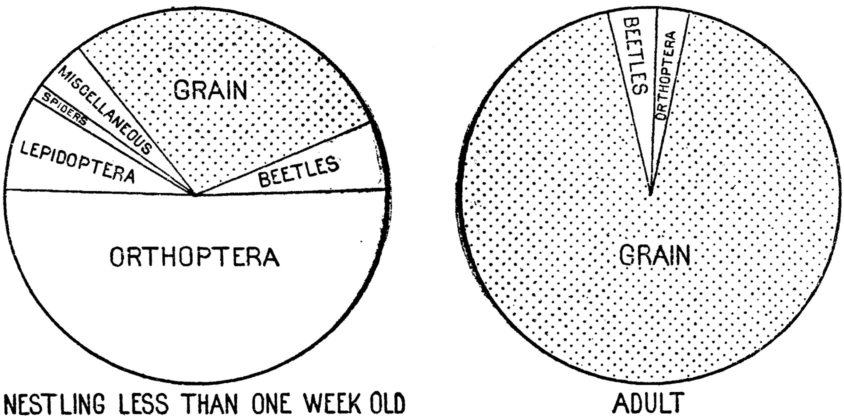


FIG. 53.—Diagram showing proportions of food of English sparrow (*Passer domesticus*), young and adult.

since they do not take any vegetable food, are more effective insect destroyers than nestling English sparrows. (Fig. 53.)

### ORIOLES.

Orioles are insectivorous birds, and though at times somewhat troublesome to the horticulturist in certain sections, are nevertheless in most localities decidedly beneficial. Three nestling orchard orioles (*Icterus spurius*) and their parents were collected at Marshall Hall, Md. Mulberries formed a quarter of the food of the old birds, but the young proved to be exclusively insectivorous. They had been fed on May-flies, spiders, caterpillars, and grasshoppers.

Mr. E. H. Forbush found the Baltimore oriole (*Icterus galbula*) feeding its nestlings on canker worms.[1] According to Nuttall, the Baltimore oriole practices regurgitation in feeding young.[2]

### BLACKBIRDS.

Examination of the stomachs of 10 nestling red-winged blackbirds (*Agelaius phœniceus*), most of which were less than a week old, showed that 1 per cent of the food consisted of weed seeds and 99 per cent of insects. Seven adult birds taken at approximately the same time had eaten grain to the extent of 20 per cent of their diet. The nestlings, contrary to the habit of most passerine, or perching, birds, had eaten

[1] Mass. Crop Report, p. 359, March, 1895.

[2] Manual of Ornithology, Land Birds, p. 163, 1832.

as many beetles (mostly weevils and leaf-beetles) as the older birds, and, singularly enough, had eaten fewer grasshoppers, the favorite food of young birds. Both nestlings and adults had eaten a number of dragon-flies. (Fig. 54.)

The food of the adult crow blackbird (*Quiscalus quiscula* and subspecies), according to the extensive investigation of Prof. F. E. L. Beal,[1] is one-third animal matter and two-thirds vegetable matter. Rather more than half the vegetable food is grain, chiefly corn. From one agricultural locality, Onaga, Kans., 124 nestlings and 65 adult crow blackbirds were collected during May and June. Nearly half of the food of the old birds was corn; the remainder was beetles, principally ground-beetles and dung-beetles, which are not injurious. The young birds were divided into three groups—the newly hatched, the

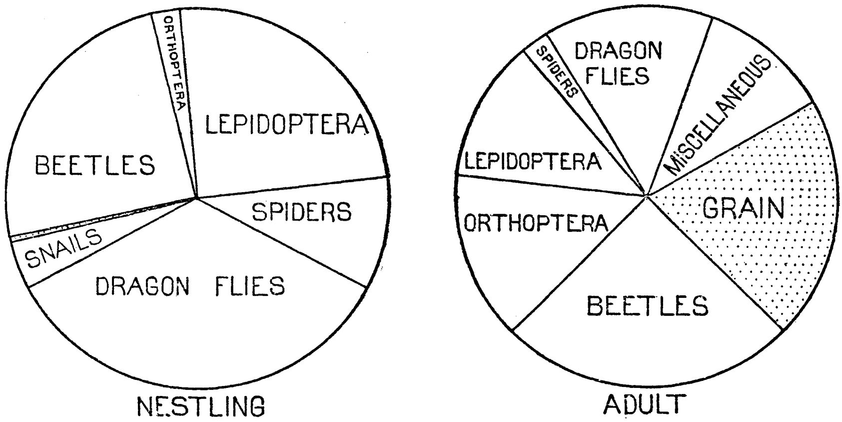


FIG. 54.—Diagram showing proportions of food of red-winged blackbird (*Agelaius phœniceus*), young and adult.

half grown, and the nearly fledged. The first group proved to be exclusively insectivorous and the third decidedly granivorous, 25 per cent of the diet being corn. The middle group was naturally intermediate in diet between the other two. The newly hatched nestlings had been fed on spiders, caterpillars (largely cutworms), and Orthoptera (grasshoppers and crickets) in approximately equal volume. From the time the young are half grown until they leave the nest one-quarter of their food is composed of beetles. The species fed to them are for the larger part such ground-beetles as the useful *Pasimachus*, *Scarites*, *Harpalus*, and *Anisodactylus;* such large scarabæids as the flashing golden-green *Phanæus carnifex* and the injurious May-beetles, in both larval and imago stages; and to a minor extent click-beetles, weevils of the genera *Epicærus*, *Phytonomus*, *Sitones*, and *Sphenophorus*, and small dung-beetles of the genera *Atænius*, *Aphodius*, and *Onthophagus*. Spiders and caterpillars seldom appear in the food of nearly fledged

[1] Yearbook U. S. Dept. Agriculture for 1894, pp. 233–248.

nestlings; they seem to be largely replaced by such limy animals as snails and crayfish. These data indicate that the service of the nestling crow blackbird in destroying insect pests, such as cutworms,

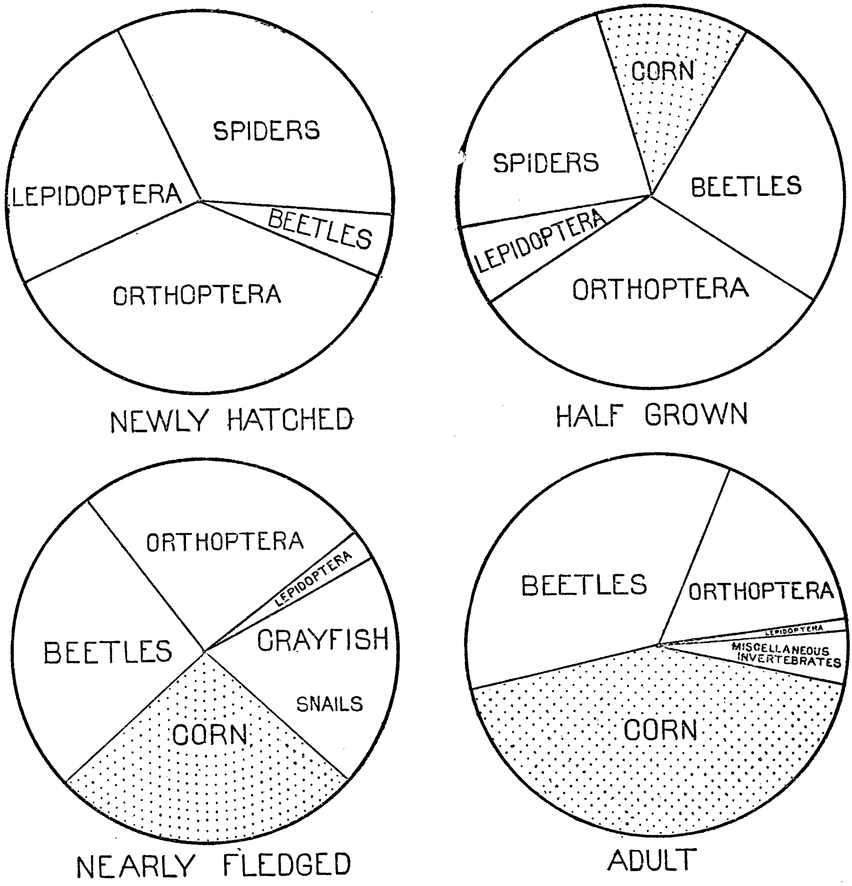


FIG. 55.—Diagram showing proportions of food of crow blackbird (*Quiscalus quiscula æneus*), young and adult.

May-beetles, weevils, and grasshoppers far outweighs the loss due to its consumption of corn. (Fig. 55.)

## CROWS.

The adult American crow (*Corvus americanus*) is vegetarian to the extent of two-thirds of its diet, and half of the vegetable food consists of grain, principally corn. But nestling crows (Pl. XLIX, fig. 2) consume large quantities of cutworms, grasshoppers, and May-beetles, both larval and adult, thus rendering considerably more service to agriculture than the adult birds. In fact, the quantity of insect pests they consume exceeds in volume more than two to one the corn they take. One hundred and thirty-nine stomachs of young crows, representing all ages from the newly hatched nestling to grown birds ready to leave the nest, have been examined in the laboratory, and the progressive changes in diet may be authoritatively stated. The first meal is usually a young grasshopper, a plump spider, or a soft cutworm. Other kinds of food are quickly added; and when the young are from one to two weeks old, about three-fourths of their diet consists of equal quantities of beetles and the flesh of vertebrates—fish, frogs, salamanders, turtles, snakes, birds, mice, and rabbits. Corn, which enters into the food before the nestlings are a week old, is still somewhat

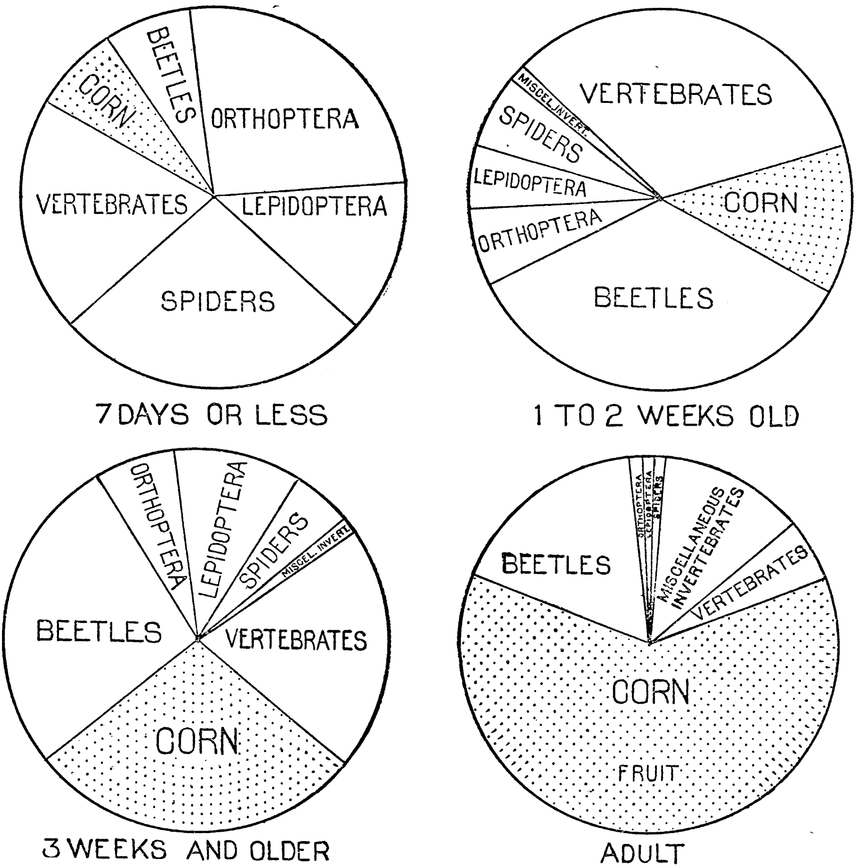


FIG. 56.—Diagram showing proportions of food of American crow (*Corvus americanus*), young and adult.

limited in quantity; but it increases as the young birds grow, until by the time they are nearly ready to leave the nest it forms rather more than a quarter of the diet, about half of its percentage in the food of the parent birds during the breeding season. At this time beetles are taken in equal quantity to corn, and vertebrates to nearly the same extent; the remaining food consists almost entirely of cutworms, grasshoppers, and spiders. (Fig. 56.)

Clark's crow or nutcracker (*Nucifraga columbiana*), a bird of the Western mountains, feeds, according to Major Bendire, on seeds of conifers, berries, and insects, largely grasshoppers. The usual food, according to Dr. C. Hart Merriam, is the large nut-like seeds of the white-bark pine (*Pinus albicaulis*). When this fails the birds feed mainly on insects, such as grasshoppers, beetles, and larvæ. Near timber line on Mount Shasta, California, young-of-the-year were observed searching the small hemlocks and firs for the little green larvæ that infested those trees.[1] The stomachs of 2 nestlings examined in the laboratory contained a pasty mass of hulled pine seeds.

### FLYCATCHERS.

The kingbird (*Tyrannus tyrannus*) is one of the most beneficial birds of the farm. It destroys asparagus beetles and rose beetles, flies injurious to stock, and other insect pests not usually molested by birds; and while it also kills honeybees, it almost invariably selects the worthless drones. This flycatcher saves grain, game, and poultry by driving away the crow, the sharp-shinned hawk, and Cooper's hawk, notorious marauders of the farm.

In the laboratory of the Biological Survey, the stomachs of 14 nestling kingbirds have been examined. The birds were mostly less than half grown, and proved to have been fed exclusively on insects, while 25 per cent of the food of adults collected at the same time consisted of fruit, principally cherries, blackberries, and blueberries. When the young are old enough to leave the nest they are often fed on these fruits. About 50 per cent of the food of young nestlings consists of crickets and grasshoppers (Locustidæ, Acrididæ, and Gryllidæ), and the remainder is divided among spiders, flies, hymenopterous insects, and an insignificant proportion of miscellaneous insects, largely moths and beetles. The old birds eat three times as many beetles and practically no spiders. (Pl. LI, fig. 2.)

Mr. Frank Bolles studied the feeding habits of great-crested flycatchers (*Myiarchus crinitus*) by imprisoning a brood of nearly fledged nestlings in a cage and observing the character of the food brought to them by their parents. It consisted of beetles, dragon-flies, cicadas, and smaller insects of various kinds.[2]

The phœbe (*Sayornis phœbe*) during the breeding season is exclusively insectivorous and feeds nothing but insects to its young. Cutworm moths were the principal food of a brood watched by Maj. C. E. Bendire,[3] while spiders and grasshoppers composed three-fourths of the food of several nestlings examined in the laboratory, the remainder being largely made up of Hymenoptera (wasps and ants) and

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[1] North American Fauna No. 16, p. 119, 1899.

[2] Auk, Vol. XVII, p. 290, 1890.

[3] Life Hist. N. A. Birds, Vol. I, p. 276, 1892.

Lepidoptera (caterpillars, butterflies, and moths). Beetles are conspicuous in the diet of the adults, while grasshoppers are considerably reduced and spiders are practically eliminated.

The wood pewee (*Contopus virens*) is also an exclusively insectivorous bird. Six nestlings examined in the laboratory contained grasshoppers to the extent of more than 50 per cent of the food, while flies, caterpillars, and spiders made up the other part.

### HUMMING BIRDS.

The food of ruby-throated humming birds (*Trochilus colubris*), as shown by Mr. F. A. Lucas, consists largely of insects and to a much smaller extent of sweets, such as sap and the nectar from flowers. Adult birds feed on gnats, ants, tiny bees, and minute parasitic wasps. Young nestlings examined by Mr. Lucas had been fed on flies, beetles, and spiders.[1] Mr. William Brewster states that humming birds twenty-four hours' old are nourished on insects,[2] and that young humming birds are fed by the process of regurgitation,[3] a habit that appears to be much more general among birds than formerly supposed.

### WOODPECKERS.

Woodpeckers live on insects and berries. The stomachs of 3 nestling downy woodpeckers (*Dryobates pubescens*) and their 2 parents contained ants, spiders, and beetles. The young had eaten more spiders and fewer beetles than the adults, but the principal food in all the stomachs was ants.

Mr. William Brewster has discovered that flickers (*Colaptes auratus*) in feeding their nestlings regurgitate the food from the gullet after the manner of pigeons. In describing this process, as performed by the male bird, he says: "Standing on the edge of the hole, the parent selected one * * * and * * * drove his bill to its base into the gaping mouth, which instantly closed tight around it, when the head and bill of the parent worked up and down with great rapidity.[4]

Some interesting observations have been made of the food of nestling yellow-bellied sapsuckers (*Sphyrapicus varius*). Mr. Brewster noted the old birds flying to the nests with their bills crammed full of insects,[5] while Mr. Frank Bolles has seen them coming to their nestlings with bills glistening with sap. Mr. Bolles secured 3 young which were nearly full grown, and kept them alive for fourteen weeks on a diet consisting of from 90 to 95 per cent of diluted maple syrup, this food being eked out with insects which came into the cage to steal the syrup. They finally died of an enlargement of the liver, which was

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[1] Auk, Vol. X, pp. 311–315, 1893.

[2] Auk, Vol. IV, p. 255, 1887.

[3] Auk, Vol. VII, p. 207, 1890.

[4] Auk, Vol. X, p. 233, 1893.

[5] Bulletin Nutt. Ornith. Club, Vol. I, p. 69, 1876.

thought to be due to the great proportion of sugar in their diet.[1] In the same locality where Mr. Bolles made his studies the writer collected a young sapsucker which had recently left the nest. Examination showed that its stomach was distended with large black ants. Ants compose about a third of the food of adult sapsuckers; but sap and alburnum, or the tissue between the hardwood and the bark of trees, are also largely taken, in securing which the birds often kill gray and white birches, and are at times injurious to apple and other trees.

### KINGFISHERS.

Kingfishers are piscivorous, but not entirely so, for they occasionally eat frogs and mice. In like manner fish constitute the principal food of the young, though sometimes other food is taken. The stomachs of 5 half-grown nestlings and 5 adults examined in the laboratory contained only fish; but those of 2 nearly fledged birds examined by Mr. R. Hayward, a correspondent of the Department of Agriculture, contained, besides fish, beetles of three kinds, ground-beetles, water-beetles, and little dung-beetles (*Aphodius*).

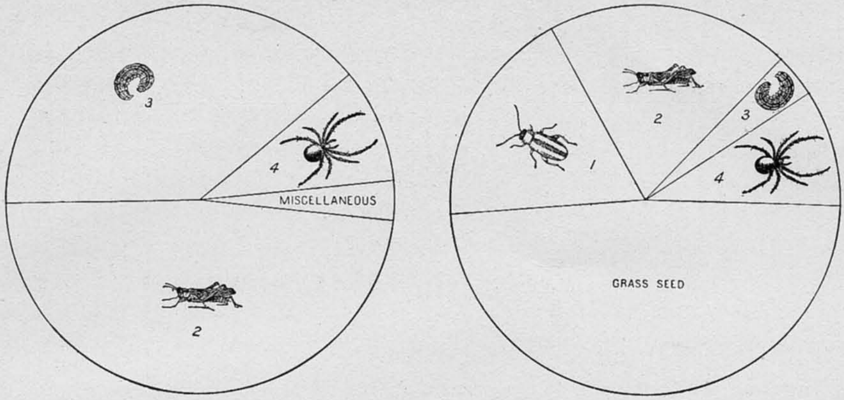
### CUCKOOS.

Cuckoos are exclusively insectivorous. They probably do more to protect foliage than any other birds, and should be rigorously protected by the horticulturist, for they subsist largely on hairy caterpillars and other larvæ which defoliate the orchard. They also eat beetles. The food of the young, as indicated by a laboratory examination of 8 nestlings of the black-billed cuckoo (*Coccyzus erythrophthalmus*), differs from that of the adults in that beetles and hairy caterpillars are absent, being replaced by grasshoppers and smooth caterpillars. Three times as many long-horned and short-horned grasshoppers were eaten by these nestlings as by 5 adults that were collected during the breeding season. (Pl. LI, fig. 3.)

### HAWKS AND OWLS.

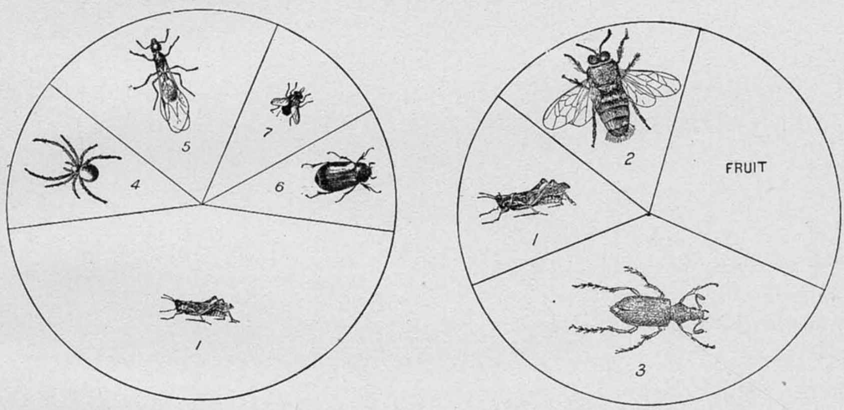
No birds have been subjected to so relentless a war as hawks and owls. Throughout the whole breadth of the land individuals, communities, counties, and States have made them the objects of their common attacks, one Pennsylvania county paying in a single year as much as $5,000 for hawks' scalps.[2] And yet, as has been shown by Dr. A. K. Fisher, only 6 of the 73 species and subspecies in the United States are injurious to man, while many are very beneficial.[3] Nestlings' stomachs show no difference from adults' in the kind of food,

[1] Auk, Vol. IX, pp. 110–119, 1892.
[2] Bulletin 3, Div. Ornith. and Mamm., Dept. Agr., p. 10, 1893.
[3] Ibid., p. 15, 1893.



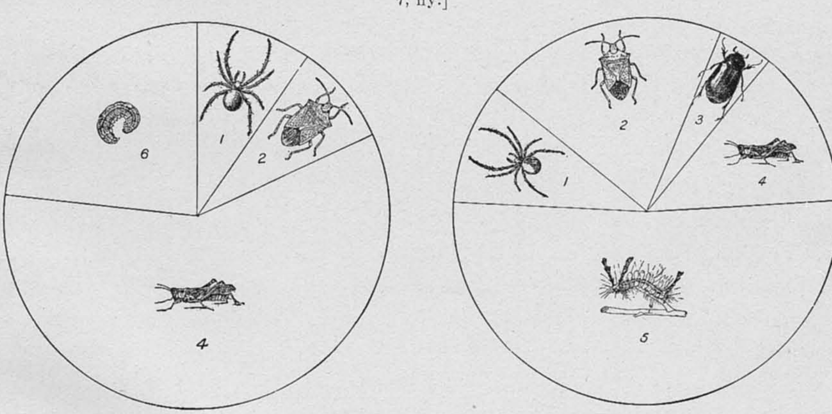

NESTLING. FIG. 1.—GRASSHOPPER SPARROW. ADULT.

[1, Flea-beetle; 2, grasshopper; 3, cutworm; 4, spider.




NESTLING. FIG. 2.—KINGBIRD. ADULT.

[1, Grasshopper; 2, drone honeybee; 3, rose-chafer; 4, spider: 5, winged ant; 6, May-beetle; 7, fly.]



NESTLING. FIG. 3.—CUCKOO. ADULT.

[1, Spider; 2, stink-bug; 3, May-beetle; 4, grasshopper; 5, caterpillar; 6, cutworm.]

## FOOD OF NESTLINGS AND ADULTS OF SOME COMMON BIRDS.

[The diagrams show the proportions of the various orders of insects in the food, each order being represented by the insect belonging to it that is most commonly eaten by the bird whose food is shown. (In the case of the Hymenoptera a division is sometimes made between the parasitic members of the order, which are very useful, and those that are neutral or injurious. The figures of insects are reduced from cuts kindly loaned by Dr. L. O. Howard.)]

NESTLING MARSH HAWKS.

[From photograph by Rev. P. B. Peabody.]

excepting that those analyzed by Dr. Fisher contained a larger proportion of flesh or fish.

The depredations of 3 hawks of the genus *Accipiter*—the sharp-shinned hawk, Cooper's hawk, and the goshawk—are responsible for the ill-repute of the hawk tribe. They are the real destroyers of birds and poultry, and richly deserve the punishment that is usually bestowed on the more harmless kinds. In 9 stomachs of young Cooper's hawks were found a slender-billed nuthatch, a flicker, the remains of a brown thrasher, the remains of a ruffed grouse, and a whole young chicken. Five of the hawks were from one nest. The voracity of these young birds is very great. One, 6 weeks old, observed by Mr. H. Justin Roddy, devoured 8 English sparrows and a mouse in a single day;[1] and one reared by the writer frequently ate its own weight of food daily, and when just able to fly escaped and caught and killed a domestic pigeon.

The stomach of the only nestling red-tailed hawk (*Buteo borealis*) examined in the laboratory of the Biological Survey contained the remains of a half-grown chicken. Two others examined by Mr. F. H. Kennard had eaten birds, frogs, a mole, and a snake.[2] It should be stated, to avoid misapprehension, that adult red-tailed and red-shouldered hawks, although commonly known as "hen hawks," subsist largely on insects and mice. It is therefore probable that the usual diet of the young is of a more commendable character than is shown by these examinations.

A young broad-winged hawk (*Buteo latissimus*) old enough to fly, which was kept for several weeks, exhibited interesting feeding habits. When a live mouse was placed in the cage the hawk pounced on it with both feet, sinking its talons into the mouse's vitals, but not once using its beak until after the death struggle. As soon as the mouse had been struck the hawk uttered continual high-keyed shrieks, spread its wings and tail, and pressed them against the ground so as to make an inclosure or tent, the opening of which it guarded with its beak. No such spreading of the wings and tail took place when the prey consisted of big moths, grasshoppers, or beetles. When a three-quarters-grown English sparrow was placed in the cage the hawk struck it a blow with one foot, clutching and killing it instantly. Still gripping the sparrow, it pulled the head off with its beak and swallowed it. Next it ripped open the body cavity and ate the whole digestive tract at one mouthful. Then beginning with one hind quarter, it finished the sparrow in four more mouthfuls.

The marsh hawk (*Circus hudsonius*, Pl. LII) is one of the most valuable destroyers of meadow mice and ground squirrels, and probably feeds its young extensively on these harmful rodents.

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[1] Auk, Vol. V, p. 246, 1888. [2] Auk, Vol. VI, p. 203, 1889.

Our national bird, the bald eagle (*Haliæetus leucocephalus*), feeds on fish, water birds, and mammals. It has been known to capture and carry off young pigs and lambs, and cases are recorded where it has attacked children. No stomachs of nestling eagles have been examined, but Mr. William Lloyd, in a letter to the Department, states that he observed an old eagle carrying prairie dogs to its nestlings.

The sparrow hawk (*Falco sparverius*) is almost exclusively insectivorous, and, according to Dr. Fisher, is a very useful grasshopper destroyer. Several newly fledged young and a dozen adults collected during the breeding season were found to have eaten practically nothing but grasshoppers.

The osprey, or fish hawk (*Pandion haliætus carolinensis*), rears its young on fish. Crow blackbirds often nest with apparent impunity in the sides of the osprey's nests.

The barn owl (*Strix pratincola*) is probably the most valuable rat and mouse catcher in the United States, as is shown by the large number of mice found by Dr. Fisher in the disgorged pellets of young birds. Three nestlings of the long-eared owl (*Asio wilsonianus*), collected by Mr. A. H. Howell and examined in the laboratory, had eaten white-footed mice and meadow mice. Nestling barred owls (*Syrnium nebulosum*), kept in captivity by Mr. Frank Bolles, killed and ate eagerly pouts and yellow perch,[1] and Mr. Otto Widmann states, in a letter to the Department, that he took from the stomach of a young barred owl the entire leg of a screech owl. The adults of both of these species are useful in their food habits.

The screech owl (*Megascops asio*) is an abundant, widely distributed, harmless little species that destroys mice and quantities of insect pests. Examination of the stomachs of a pair of screech owls and their 2 young, which had just left the nest, showed that all had been eating May-beetles and that the young had also eaten lizards. May-beetles, some frogs, and a few grasshoppers were brought by the parent birds to a brood of nestling screech owls confined in a cage by the writer. And Mr. J. H. Gaut, of the Biological Survey, is authority for the statement that crayfish are fed by the old birds to their young.

The great horned owl (*Bubo virginianus*) is a fierce, powerful bird, and in some localities is very destructive to poultry and game birds. As the damaged reputations of all the hawks are mainly due to the ravages of the *Accipiters*, so the depredations of this large owl are largely responsible for the ill-repute of the owl tribe; yet where chickens are carefully sheltered at night the great horned owl may be ranked as one of the allies of the farmer, for it destroys a great many injurious rodents and feeds quantities of them to its nestlings, as is shown by some of the observations made. In and about a nest containing young of this species were found the remains of 113 common

[1] Auk, Vol. VII, pp. 103, 104, 1890.

house rats,[1] while in another were the remains of 2 muskrats with those of a wild duck.[2] A third nest contained a lark finch, a mocking-bird, and a Cooper's hawk.[3]

The Florida burrowing owl (*Speotyto cunicularia floridana*) is a useful destroyer of both insect pests and mice. In an interesting account of its feeding habits, Mr. Samuel N. Rhoads states that in and about burrows containing young he found the remains of grass-hoppers, beetles, mice, fish, snakes, lizards, frogs, and crayfish, and the feathers of a savanna sparrow, a Cuban night hawk, and a bobo-link.[4]

The pigmy owl (*Glaucidium gnoma*) is the smallest, but by no means the least beneficial, of the owls. Little is known of the food of the young, but in a nest containing several Maj. C. E. Bendire found a chipmunk and the feathers of some birds.[5]

### VULTURES.

Mr. William Palmer secured and kept in captivity a downy nestling of the turkey buzzard (*Cathartes aura*). It was about the size of a man's fist, and ate every kind of meat or fish that was offered it, but preferred putrid flesh full of maggots. Another young vulture of the same species, reared by Mr. H. Justin Roddy, frequently devoured at a single meal a water snake (*Tropidonotus sipedon*) 3 feet long.[6]

### PIGEONS.

In June, 1878, Dr. C. Hart Merriam collected in the Adirondacks a number of adult passenger pigeons (*Ectopistes migratorius*) and their squabs, and found the crops of all distended with beech nuts.

Five squabs of the mourning dove (*Zenaidura macroura*, Pl. LIII, fig. 1) were examined in the laboratory of the Biological Survey; 30 per cent of their food was composed of seeds of sorrel (Oxalis), spurge, ragweed, sunflower, pigeon-grass, and corn, while the remaining 70 per cent consisted of irregular endosperm fragments of the above seeds from 0.5 to 3 mm. in diameter, probably the regurgitated matter commonly known as "pigeon's milk." Adult doves collected during the breeding season had eaten the same kinds of seeds, together with those of violet, polygonum, buckwheat, and wheat. One young dove which had recently left the nest had in its crop 7,500 seeds of yellow sorrel (*Oxalis stricta*).

### GALLINACEOUS BIRDS.

Our gallinaceous birds, such as grouse, quail, pheasants, etc., are not exclusively vegetarian in diet, as is popularly believed, but are

[1] Bulletin 3, Div. Ornith. and Mamm., Dept. Agr., p. 176, 1893.
[2] Forest and Stream, Vol. XXVIII, no. 5, p. 320, 1884.
[3] Letter from William Lloyd, Paint Rock, Tex.
[4] Auk, Vol. IX, pp. 6–8, 1892.
[5] Auk, Vol. V, p. 370, 1888.
[6] Ibid., p. 245, 1888.

mixed feeders, and probably nourish their newly hatched chicks principally on insects. Quail (*Colinus virginianus*) and prairie chickens (*Tympanuchus americanus*) destroy such dreaded pests as cutworms, army worms, twelve-spotted cucumber beetles, chinch bugs, and Rocky Mountain locusts. Newly hatched prairie chickens are insectivorous, and, according to Maj. C. E. Bendire, subsist almost exclusively on grasshoppers when these insects are plentiful.[1] It is believed by some ornithologists that the extensive legalized slaughter of these birds, which in some sections has amounted to practical extermination, is largely responsible for the increased depredations of certain insect pests. In any event, they are of too much value to the farmer to be killed off recklessly, and whenever the sportsman is privileged to shoot them the farmer should demand full compensation. In the laboratory of the Biological Survey 2 recently hatched Texas prairie chickens (the variety known as *Tympanuchus americanus attwateri*) have been examined. They contained 1 tree cricket, 5 undetermined caterpillars, 1 imago of the very destructive Angoumois grain moth, 1 leaf beetle (*Monoxia puncticollis*), and 19 twelve-spotted cucumber beetles (*Diabrotica 12-punctata*), which not only feed on the cucumber, but are injurious to more than a dozen kinds of cultivated plants. Dr. B. H. Warren collected a chick of a ruffed grouse (*Bonasa umbellus*) about a week old, and found that it had eaten a white grub, 7 harvestmen (spiders), and 13 caterpillars. The young of the introduced Mongolian pheasant (*Phasianus torquatus*) are insectivorous. In captivity they are reared on maggots. They have been known to feed eagerly on potato beetles, a fact which should be emphasized, since so few birds will touch these pests.

### SHORE BIRDS.

The data concerning the food of young shore birds are somewhat limited, consisting merely of a few facts relating to the woodcock and true sandpipers. Some downy woodcock chicks about the size of hen's eggs were obtained by the writer and reared on earthworms, which form a large proportion of the food of adult woodcock. Dr. B. H. Warren found that the stomachs of 4 young woodcock examined by him contained nothing but caterpillars. One of the parent birds, on dissection, proved to have fed on earthworms and beetles.[2] Several sandpipers' stomachs have been examined in the laboratory of the Biological Survey. Two young of the Pribilof sandpiper (*Tringa ptilocnemis*), still in the downy stage, had eaten a seed, a fly, and a quantity of carabid beetles and parasitic wasps. One of the parent birds had eaten the same kinds of beetles and wasps. The stomach of

[1] Life Hist. N. A. Birds, Vol. II, p. 92, 1897.

[2] Birds of Penn., 2d ed., p. 80, 1890.

a quarter-grown solitary sandpiper (*Actitis macularia*), examined by Prof. F. E. L. Beal, was found to contain 1 small spider, a minute caterpillar, 2 tiny wasps, 1 assassin bug, 1 negro bug, several aquatic beetles, 7 weevils (*Tyloderma*), several larval carabid beetles and 10 adults (*Bembidium* and *Dyschirius*).

### CRANES.

Some interesting facts about the feeding habits of young sandhill cranes (*Grus mexicana*) are furnished by Prof. F. E. L. Beal, who captured a downy nestling of this species. This chick, which was so young that it weighed barely a pound, thrived on a diet of earthworms, carabid beetles, and meat. When it was two months old there was an outbreak of seventeen-year cicadas, which afforded an abundant and greatly relished food supply, and of which it would often eat more than a quart in a single day. It sometimes swallowed a handful or more of these cicadas while they were singing; and it was a curious fact that the singing was continued for several minutes.[1]

### WATER BIRDS.

The food of nestling water birds appears to be similar to that of their parents, that is, principally fish. Mr. E. W. Nelson states that he found a downy chick of the black-throated loon (*Urinator arcticus*) with a half-digested tomcod about 6 inches long in its gullet.[2] Puffins feed their young on fish, and a curious difference in manner of transportation of this food has been observed. In Alaska the tufted puffin (*Lunda cirrhata*), Dr. A. K. Fisher states, holds by the head the fish it carries to its rookeries; while in the case of the horned puffin (*Fratercula corniculata*), another method prevails, according to Mr. E. W. Nelson, who says of this species: "Overhead circled hundreds of the birds, nearly all of which carried fishes in their beaks for their young. These fishes were sticklebacks and sand-lances. Some of the birds carried from 3 to 5 small fishes at once; the latter were all placed side by side crosswise in the bird's bill."[3]

Auklets live mostly on crustacea. Mr. William Palmer states that in Alaska he has observed the paroquet auklets (*Cyclorrhynchus psittaculus*) flying to their nestlings with their mouths and gullets greatly distended by quantities of a small, almost colorless crustacean.[4] He also notes that the small young of Pallas murre (*Uria lomvia arra*) are fed with disgorged crustaceans, but that when the nestlings have grown larger this diet is largely supplanted by one of fish.[5]

Both adult and nestling marine gulls and terns are piscivorous. In Alaska Dr. A. K. Fisher has observed the Pacific kittiwake (*Rissa*

[1] Iowa Agricultural College Quarterly, p. 45, July, 1879.
[2] Nat. Hist. Alaska, p. 37, 1887. [3] Ibid, p. 39, 1887.
[4] Fur Seals and Fur-Seal Islands, part 3, p. 385, 1899. [5] Ibid, p. 391, 1899.

*tridactyla pollicaris*) and the short-billed gull (*Larus brachyrhynchus*) carrying fish to their nestlings; and in Mexico Mr. E. A. Goldman has made similar observations in the case of the laughing gull (*Larus atricilla*). According to Mr. William Palmer, the fishermen of Newfoundland capture young downy herring gulls (*Larus argentatus smithsonianus*, Pl. LIII, fig. 2), rear them in pens on fish offal, and utilize them for food later, when fresh meat is scarce.[1] An inland colony of Franklin gulls (*Larus franklini*) was found in Minnesota by Dr. T. S. Roberts. The parent birds were feeding their young by regurgitating into them the nymphs of dragon flies.[2]

The feeding habits of terns are similar to those of gulls. Mr. E. W. Nelson states that in Alaska he saw the Arctic tern (*Sterna paradisæa*) feeding its young on sticklebacks. Mr. E. A. Goldman has observed breeding terns on the Arcas Keys in Mexico under most favorable circumstances. In one instance he found from 200 to 300 young royal and sooty terns (*Sterna maxima* and *Sterna fuliginosa*) running along the beach, and often herding together like a flock of sheep. Every few moments from 1 to 3 old terns would sail in gracefully, carrying fish in their beaks. Very often a parent on alighting failed to find its own young in the struggling, pushing flock of little ones. Instead of feeding the young of another, it usually picked up the fish which it had laid down, described one or two circles, and then descended to the beach again, perhaps to find its own young far enough isolated from the flock, and to feed it as it came up with fluttering wings and open mouth.

Adult cormorants are largely piscivorous. On some of the rivers in China the native fishermen employ tame cormorants in their fishing. A band is ingeniously placed round each bird's throat to prevent it from swallowing its prey, which it catches by diving over the gunwale of the boat. Every now and then it is rewarded with the smaller and less valuable fish. In writing of the feeding habits of the red-faced cormorant (*Phalacrocorax urile*), Mr. E. W. Nelson says: "The young appear after three weeks' incubation, and are without feathers and almost bare even of down. They grow rapidly and are fed by the old birds ejecting the contents of their stomachs [gullets], composed of small fish, crabs, and shrimps, over and around the nest."[3] On St. Matthew and St. Lawrence islands, Alaska, cormorants are the only fresh meat obtainable by the natives in winter.

Pelicans, as might be expected, appear to be entirely piscivorous. Of the feeding habits of the brown pelican (*Pelecanus fuscus*), Mr. Frank M. Chapman says: "Immediately after the parent returns from its fishing expedition the young cluster about it and the outcry begins. But the old one takes it very patiently, sitting quite still until ready to open its creel, as it were. Then he takes a stand a little above the

[1] Proc. U. S. Nat. Mus., Vol. XIII, p. 254, 1890.

[2] Auk, Vol. XVII, p. 280, 1900.

[3] Nat. Hist. Alaska, pp. 65, 66, 1887.

FIG. 1.—NESTLING MOURNING DOVES.
[From photograph by Rev. P. B. Peabody.]

FIG. 2.—NESTLING HERRING GULLS.
[From photograph by Mr. William Dutcher.]

young, drops his lower bill with its pouch, when at once the young thrust in their heads to secure their morning's catch."[1]

The data at hand relating to the food of young ducks are limited, but a few facts have been collected. A mallard (*Anas boschas*) duckling in the down, collected and examined by Dr. A. K. Fisher, had its stomach distended with grasshoppers.[2] Domesticated ducklings of this species were noticed feeding by the writer, but these were stuffing themselves with May-flies. Newly hatched wood ducks (*Aix sponsa*) have been seen by Prof. F. E. L. Beal picking from the surface of pools May-flies, locusts (Acrididæ and Locustidæ), and other insects. A third-grown wood duck was observed by Mr. George Marshall, of the U. S. National Museum, with the legs of a small frog sticking out of its bill. It is probable that young ducks are fed to some extent on frogs, as well as on tadpoles, mollusks, crustaceans, and small fish.

More definite knowledge is at hand concerning the food of young herons, especially green herons (*Ardea virescens*), and black-crowned night herons (*Nycticorax nycticorax nævius*). Dr. B. H. Warren, in a letter to the Department, states that he visited a heronry of black-crowned night herons and examined the stomachs of 10 adults and 10 nestlings, all of which had fed exclusively on fish. In another heronry of this species Mr. W. E. Endicott discovered that the young were provided with pout, pickerel, and herring.[3] Four nestling green herons dissected by Dr. Warren had also fed exclusively on fish. Several adult birds examined by the Biological Survey had eaten fish and also crayfish and aquatic insects. Herons may in certain sections prove injurious to pisciculture, but a number of species have some beneficial habits, such as feeding on injurious insects and mice, and in Louisiana the white herons (*Ardea candidissima* and the young of *Ardea cærulea*) are, according to Mr. Lester F. Dewey, assistant botanist of the Department of Agriculture, known as "crawfish birds," and are most rigorously protected because of their feeding on crayfish, which tunnel through the levees and at times causes great disasters.

## CONCLUSION.

It will be observed that whatever the character of the food of the adult birds, the young, excepting those of doves and pigeons, are at first fed on an animal diet, and that this diet is gradually changed, where change is necessary, to conform to that of the mature bird. This is probably due to the fact that animal food has a higher nutritive value and is more easily digested than the available vegetable food. As the nestlings increase in weight from one-fifth to one-half

[1] Bird Studies with a Camera, p. 210, 1900.
[2] North American Fauna No. 7, p. 15, 1893.
[3] Am. Nat., Vol. I, p. 344, 1867.

daily, and at certain stages of growth require daily more than their own weight in insects, it is essential that their food should be capable of the most rapid digestion; it must also be readily obtainable. Spiders, grasshoppers, caterpillars, and crickets answer these requirements very well and are a favorite nestling food with many species of passerine, or perching, birds. Birds that are largely vegetarian, such as the crow, crow blackbird, catbird, robin, cedar waxwing, and English sparrow, mingle fruit or grain in constantly increasing quantities with the insects fed to their young, though insects usually remain the chief component of the food until maturity is nearly reached. But these birds generally substitute such insects as hard beetles—carabids, dung-beetles, May-beetles, and weevils—for the softer food of other perching birds. The caterpillars selected are generally such hairless kinds as canker worms, cutworms, and army worms, all of which are serious pests. But hairy caterpillars are eaten to a certain extent. Mr. E. H. Forbush has noted 13 different species of birds giving tent caterpillars and the caterpillars of the brown-tailed and gipsy moths to their young.[1]

The amount of food required by the nestling and the unremitting zeal and attention demanded of the parent are astonishing, and result in the destruction of great quantities of injurious insects. Two or three examples of this have been given. Another may be added, with an estimate of the saving effected through the removal of pests: During the outbreak of Rocky Mountain locusts in Nebraska in 1874–1877, Prof. Samuel Aughey saw a long-billed marsh wren carry 30 locusts to her young in an hour.[2] At this rate, for seven hours a day, a brood would consume 210 locusts per day, and the passerine birds of the eastern half of Nebraska, allowing only 20 broods to the square mile, would destroy daily 162,771,000 of the pests. The average locust weighs about 15 grains, and is capable each day of consuming its own weight of standing forage crops, corn and wheat.[3] The locusts eaten by the nestlings would therefore be able to destroy in one day 174.397 tons of crops, which at $10 per ton would be worth $1,743.97. This case may serve as an illustration of the vast good that is done every year by the destruction of insect pests fed to nestling birds. And it should be remembered that the nesting season is also that when the destruction of injurious insects is most needed, that is, at the period of greatest agricultural activity and before the parasitic insects can be depended on to reduce the pests. The encouragement of birds to nest on the farm and the discouragement of nest robbing are therefore more than mere matters of sentiment; they return an actual cash equivalent, and have a definite bearing on the success or failure of the crops.

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[1] Mass. Crop Rept., pp. 32, 33, September, 1899.
[2] Rept. U. S. Entom. Comm., Appendix II, p. 18, 1878.
[3] Yearbook U. S. Dept. Agriculture, for 1894, p. 222.

# DEVELOPMENT OF THE TRUCKING INTERESTS.

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## TRUCK FARMING IN GENERAL.

Truck farming may be defined for the purposes of this paper as differing from market gardening in that the produce is grown for shipment to a distant market, not to be sold from the wagon in the home market; and from general farming, in the usually perishable nature of the product. The term as defined by others means the raising of truck, or garden produce, on a large scale, whether for near-by or distant markets. According to this view it is simply market gardening on a large scale.

It is hard to decide just what should be considered as constituting the truck crops. Thus, in the North, potatoes, onions, and, in some sections, cabbage take rank among the staple farm crops, along with wheat and corn. They may be stored and kept for many weeks or months, and are handled by the ordinary channels of trade like other staple farm products. As grown in the South, these crops are much more perishable, and from the way in which they are sold and handled they take their place among the leading truck crops. Again, strawberries and other small fruits, especially those occupying the land for a comparatively short time, may properly be classed as truck, while orchard fruits would not be so considered.

It has only been attempted here to sketch in a general way the development of the trucking interests of the United States. The lines on which progress has been made are indicated, and incidentally some improvements in methods are suggested. The scope of the treatment forbids any attempt at a separate discussion of the principal truck crops. An ample fund of information along this line may be found in the bulletins and reports of the Department of Agriculture and of the various State experiment stations.

The trucking business, which is now a very important one in many parts of the United States, is a modern outgrowth, due to the improvement in facilities for rapid transportation, from the older occupation of market gardening. Before the advent of steam navigation and of railroads each town and city was dependent for its supply of perishable vegetable products on the immediately surrounding country, and the markets were only supplied during the brief period when each of these products was locally in season, except as small quantities were produced under glass. Now the cities, and even the smaller towns, in all parts of the country are abundantly supplied with fresh fruits and vegetables during the entire year. The volume of this business is still increasing much more rapidly than the increase in population, owing to improved methods of distribution and to the consequently increased consumption per capita due to the abundant and cheap supply. The business is thus a benefit to the consuming classes by furnishing abundantly and cheaply many healthful and palatable articles of food. It has grown to be of such commercial importance that in many of the larger cities entire streets are devoted wholly to the produce business. It furnishes many railroad and steamship companies with one of their most profitable classes of freight, and to the farmer engaged in truck raising it furnishes a great variety of money crops. It also serves to educate him in business usages and in better methods of fertilizing and cultivating the soil. The modern improved methods in agriculture, known collectively as intensive farming, have nearly all had their origin in the hands of truck farmers and market gardeners. No other class of the rural population is more alert in utilizing the newest researches and discoveries in all lines of agricultural science, and none keeps in closer touch with the agricultural colleges and experiment stations. The manufacture of "packages" for the transporting of truck crops to market has in itself grown to be a large business in many parts of the country, and the fertilizer merchants and manufacturers find in the truck farmer a customer for their highest grade of goods.

Since the benefits of this industry are enjoyed by so many classes of people, it is unfortunate that the losses which are inevitable in handling such perishable products have so far fallen almost exclusively on the producer. By the system of shipping on commission which still prevails and was once well-nigh universal, the grower must take not only his legitimate risks of loss from unfavorable seasons, insects, and diseases, but also the risks of damage during transportation, and of overcrowded markets that belong more naturally to the commercial side of the business. The produce merchant is better able than the average grower to keep posted on the probable requirements of the different markets, and in those localities where the custom has become established of selling to buyers at the shipping point better average prices have been realized by the growers, the element of risk that has always militated against their full success having been in some measure eliminated. Notwithstanding the fact that truck farming has more risks than ordinary farming, or perhaps partly on account of these risks and the consequent chances for greater profits, the business has proved an attractive one to many people, and instances are rare where communities having once embarked in it give it up for other lines of production.

## HISTORICAL AND GEOGRAPHICAL REVIEW OF TRUCK FARMING.

One of the earliest centers for the development of truck farming in its present sense was along the shores of Chesapeake Bay, where fast-sailing oyster boats were employed for sending the produce to the neighboring markets of Baltimore and Philadelphia. In a similar way the gardeners about New York early began pushing out along Long Island, using the waters of the Sound for transporting their produce. The trucking region on the eastern shore of Lake Michigan is another example of the effect of convenient water transportation in causing an early development of this industry. The building of the Illinois Central Railroad opened up a region in southern Illinois that was supposed to be particularly adapted to fruit growing. In the early sixties a considerable number of people moved into southern Illinois, mostly in the neighborhood of Cobden, Union County, for the purpose of planting orchards, being attracted by the high prices obtained in the Chicago market for early fruits. While waiting for orchards to come into bearing they naturally tried experiments with vegetables and small fruits. Meeting with success, especially with strawberries, tomatoes, and sweet potatoes, the business gradually assumed considerable proportions. With the close of the civil war and the subsequent opening up of direct north and south lines of railroad, the business has gradually extended from this center to various parts of Tennessee, Mississippi, Arkansas, and Texas. Mobile and New Orleans were early noted for their market gardens, and with the advent of rapid transportation they soon became important shipping centers. In the East the business gradually extended down the coast from the Peninsula to Norfolk, and then to Charleston, Savannah, and Florida.

## FACTORS IN THE DISTRIBUTION OF THE TRUCK-FARMING BUSINESS.

This steady progress from the North southward has been largely due to the effort to produce earlier and earlier crops, so as to take advantage of the high prices prevailing at the first of the season. The cheapness of Southern lands as compared with those of the Northern trucking regions has been another factor in promoting this southward movement. These advantages of the far South have been to some extent offset by higher transportation charges, and, with the more perishable products, by the greater danger of loss in transit, and the greater difficulty of placing them on the market in a fresh, attractive condition. It is now recognized that the far South can not compete with more northern localities at the same season with most crops. For instance, when Mississippi tomatoes begin moving freely they take the market from the Florida shippers. In turn, Mississippi is forced out by Tennessee and southern Illinois, the latter holding the Northern markets till the home-grown supplies come in. Another reason that would seem to set a limit to the indefinite expansion of the business at the far South is the more limited consumption of most truck products during the winter months. It is true that a small quantity of any fruit or vegetable out of season always commands a fancy price, but a much less quantity can be sold even at a small price than in the summer, when the human system seems to imperatively demand these more succulent foods. Notwithstanding these evident limitations, the greatest expansion of the business during the last decade has been in the far South, Florida and southern Texas.

The great bulk of all truck shipments are from south to north in order to supply the great Northern cities with these goods before they can be produced by local gardeners. The business is, however, by no means confined to this northward movement. Vast quantities of northern-grown potatoes, cabbage, onions, and celery are sold in the Southern States every winter. The Illinois Central long ago earned the sobriquet of "The cabbage route," from the fact that it was moving train loads of cabbages north daily during spring and early summer, and equally large quantities south during fall and winter.

Some of the principal centers for the trucking business have been mentioned, but they may be recapitulated as follows: Beginning at the north and east, we have first Long Island and then the Peninsula, including Delaware, parts of New Jersey, and the portions of Maryland and Virginia lying east of the Chesapeake Bay. Following down the Atlantic coast, we find Norfolk, Charleston, and Savannah, each the center of an important trucking district. For the purposes of this paper, the entire State of Florida may be considered as constituting another district, though this might well be further subdivided. Extending from north Florida up through middle Georgia is the great watermelon region. Then comes Mobile and the adjoining territory in south Alabama, and New Orleans, with the delta region of Louisiana. The great extension of the business during the past few years along the Texas coast entitles this district to special mention. Passing north from Mobile and New Orleans along the Mobile and Ohio and the Illinois Central railroads, the business is established at various points in Mississippi, the most notable being Crystal Springs, which has long been the greatest tomato-shipping point in the world. Farther north is the west Tennessee district, the melon region in southeast Missouri, and the long-established center in southern Illinois. Still farther north is the rather important district about Muscatine, Iowa, and the famous Benton Harbor region of western Michigan. California is mostly known as a fruit-growing State, but she, too, ships large quantities of products that can properly be classed as truck. The business is by no means confined to the areas mentioned, as there are many other points with almost equal claims for recognition. Most of these districts grow a great variety of produce, but there are points that have become famous for the production of some specialty, like

Kalamazoo, Mich., for celery; Crystal Springs, Miss., for tomatoes, and Rocky Ford, Colo., for cantaloupes.

Just what causes have led to the present distribution of the business it is not in all cases easy to determine. Of course, convenient and rapid transportation has always been one of the controlling factors. Without this the business is impossible. The suitability of soil and climate has obviously been another important element. The soil conditions of the various trucking centers are very diverse, and make it difficult to decide just what kinds of soil will and what will not admit of the building up of a successful trucking business. Twelve of the localities mentioned above have a more or less sandy soil, but it varies from the almost pure white sands of some parts of Florida and the southern part of the Peninsula to the rich black sandy loams of the Texas coast and of southeast Missouri. Of the other localities, New Orleans has a deep black alluvial soil; Crystal Springs, Miss., a light clay loam with some admixture of sand; west Tennessee and southern Illinois a stiff yellow clay with a thin covering of loam. There are other vast areas with equally suitable soils and equally well situated as to transportation where the business has never gained a foothold. The industry is confined somewhat strictly to well-defined centers, where advantage can be taken of carload freight rates. The isolated shipper who can not fill cars is always placed at a disadvantage, owing to the higher proportional freight charges on small lots. The particular location of the present shipping centers seems often to have been due to the fact that some pioneer in the business chanced to settle there and to succeed so well as to be copied by his neighbors.

## TRANSPORTATION OF TRUCK PRODUCTS.

### EVOLUTION OF TRANSPORTATION FACILITIES.

The transportation question is always one of prime importance to the trucker. As has been stated, the business first originated at points where water transportation was available, and these points still have a decided advantage over those dependent entirely on rail shipments, especially for the handling of the bulkier and heavier products. Water freight rates are usually lower than rail rates, the produce is less liable to injury from jolting and bruising, and it is not so much exposed to dust, cinders, and heat. Water transportation has played an important part in building up the business at all points on the Atlantic seaboard. It is slower than rail transportation, and for the more perishable products this becomes an insuperable objection where the distance is great.

Such products formerly all went by express, and this method is still employed for small lots, especially early in the season, when prices are high. The objections to express shipments are twofold—first, the very high charges, which, when low prices prevail, are prohibitive for most crops, and, second, the frequent damage resulting from the necessarily hasty and often careless handling in loading and the consequent lack of proper spacing in the car to insure good ventilation. The day has long passed when the trucker can expect to ship more than a very small part of his goods by express.

Of course, the heavier, bulkier products, like potatoes, cabbage, and watermelons, have always gone by freight where water transportation is not available. At first shippers were obliged to use either common box cars or the rough open cattle cars, neither being suited to the purpose. The box cars were too tight and excluded the air so completely as to induce heating, while the stock cars were too open and exposed the goods to the weather; they were not provided with springs, and the constant pounding and jarring injured the contents. As the business grew in volume and importance, better and better facilities were afforded by the roads, finally resulting in the modern ventilated fruit car, with springs and air brakes like a passenger coach, and with its many barred openings for ventilation, covered with wire netting to keep out cinders and prevent thieving. With the advent of these better cars it was found possible to ship by freight even the more delicate products, such as strawberries, for considerable distances, provided care was taken in loading to properly space the packages so as to secure thorough ventilation. In fact, where the time was no greater such freight shipments uniformly arrived in better condition than express shipments. Of course, the cost was much less than by express. This led to strenuous efforts to have these ventilated freight cars attached to passenger trains and run through on express time. Often this has been done, of course for an added charge, but on many roads contracts with the express companies prevented this. The roads handling a large produce business soon yielded to the continued pressure from the shippers and put on special fast fruit and produce trains, run as nearly as possible on passenger time, whenever the quantity of shipments offered justified it. This was a distinct advance in the evolution of transportation methods, and it is still the method in vogue for handling all perishable crops for near markets and the more resistant ones for all parts of the country.

### METHOD OF LOADING TRUCK PRODUCE.

Where produce was marketed in boxes or crates much had to be learned as to the best methods of loading in the car to secure the best results from the ventilation and to prevent damage by the shifting of the load. The plan now quite uniformly adopted is to begin the load in either end by laying down a row of packages with their ends snug against the end of the car, but with 3 to 6 inches space between the packages.

Two half-inch strips, as long as the car is wide, are laid down on the row of packages, one at the front and one at the back, and these are nailed down by a small nail driven into the ends or heads of the crates or boxes. Another layer of packages is placed on these strips, taking care to place each box directly over the one below it, so as to preserve the air spaces from bottom to top of car. Strips are nailed on these as before, and other layers of packages added until the desired height is reached. Another tier is then started in the same way, taking care to jam the ends of the packages squarely against those of the first tier, so as to preserve the air spaces intact, not only from bottom to top, but from end to end of the car. When the car is in motion a current of air comes in at the front-end ventilators and passes through between the tiers of packages without interruption and escapes at the rear ventilators. Side ventilation is usually also provided, but it is much less important than that from end to end. When the middle of the car is reached it becomes necessary, unless the packages chance to closely fill the space, to brace the piles solidly to prevent their shifting by the bumping of the cars in switching, or in starting and stopping. This is done by placing pieces of 6-inch fence board upright against each tier of packages on either side and reaching from the floor to the top of the car. Stout cross strips are nailed to these uprights a foot or so from the floor and from the top. Braces are sawed about an inch longer than the measured distance between these opposing sets of crossbars. The brace pieces are put in place and are forcibly driven home. This settles the load together very solidly. The braces are toe-nailed in place to prevent the possibility of their becoming loosened and dropping down. When thus loaded, nothing short of a collision can cause the load to shift; and yet no two packages are in contact except at the ends, each being surrounded by a rapidly moving current of air as long as the car is in motion.

When open baskets are used for shipping, as is done so commonly in the East, it is necessary to put temporary shelving in the cars, and the baskets are jammed tightly on the shelves to prevent them from falling over. This, too, secures good ventilation. In some sections covered baskets are used that can be piled one on top of another in the car, and these can be loaded in much the same way as the boxes or crates.

The style of cars and of loading here described, when the cars are carried on a fast schedule, represents probably the highest attainable development for open or ventilator transportation, and indeed it is sufficiently satisfactory for a large class of goods. For the more delicate products it has two drawbacks: (1) The packages are not protected from dust, the contents, especially near the ventilators, being often much injured by it and by the constant draft of warm air, which often wilts tender vegetables, so that they reach market in a flabby, unattractive condition; (2) the time limit for the successful shipment under ventilation of such delicate crops as strawberries is so short that it restricts the business to comparatively narrow bounds. Forty-eight hours may be considered as the limit of safety with products of this class, even with favorable weather conditions. When it is either very hot or very rainy, serious losses may occur on even a twenty-four-hour run.

### REFRIGERATOR TRANSPORTATION[1] OF TRUCK PRODUCE.

The possibility of using ice for preserving the freshness of fruits and vegetables in transit seems to have early suggested itself. So far as known to the writer, Mr. Parker Earle, then residing at Cobden, Ill., was the first to experiment in this direction. In a recent letter he describes his early attempts and final success with refrigeration, as follows:

I think it was in 1866 that I built the first twelve big refrigerator chests for shipping strawberries. I sent them to Chicago, Pittsburg, New York, Memphis, and New Orleans, all by express. Where the express company followed instructions and re-iced the berries, they carried quite well. They held 200 quart baskets of berries each and 100 pounds of ice. The express rates were so high and the neglect to re-ice was so frequent that I had to give it up. Similar chests to these, only larger, were used from Charleston to New York by steamship lines at about the same time. It was later that the small "pony" refrigerator boxes began to be used from Florida. My boxes weighed 600 pounds each when loaded. These pony boxes weighed about 100 pounds.

The first attempt at carrying carloads of strawberries under refrigeration was made by Mr. Davis, of Detroit, about 1868. He came to Cobden with a car that was made for refrigerating beef and fish. It contained a vertical cylinder in each corner of the car about 15 inches in diameter, and was iced from the top of the car, using salt with the ice. The consequence was the freezing of a part of the berries, while the balance of the load was very unequally cooled. The result was a loss, which did not invite a repetition of the venture.

The experiment interested me greatly, and I thought I saw why it failed—that the refrigeration was very unequal and in part very excessive. The following year I got a car from the Michigan Central Railway Company that was built to carry dairy products. It was loaded with berries by an association of growers at Cobden. It held about a ton of ice in each end. I went ahead to Detroit to make sure of a market and the car was loaded by the growers. With this half charge of ice the load of berries might have gone through in fair condition but for the misfortune that some wise railroad man took out the plugs from the ice boxes in the roof to give the berries "a chance for a little air" and left them out. Of course the ice was melted in a day and the bulk of the cargo was ruined. This discouraged community efforts in this line at that time. I, however, began experimenting with our own berries by building a cooling box in our packing shed at Anna, Ill., and holding the berries in it twenty-four hours to cool off and then sending them by express. It was found that those so cooled went into Chicago in better condition than those freshly picked from the field, although they were one day older. Repeated experiments served to establish this fact. This decided my plans. I went to Chicago and engaged the best refrigerator car then made—the old Tiffany patent—with ice box, V-shaped, suspended from the roof and running the full length of the car. The utmost capacity of this ice pan was 1½ tons. I knew well

[1] Much additional information regarding refrigerator transportation will be found in a separate paper in this Yearbook, entitled "The influence of refrigeration on the fruit industry."—Ed.

that this quantity would not both cool off a load of berries and keep it cool for two or three days, so I built a cooling house at Anna large enough to hold 10 tons of strawberries and I cooled the load down for a day in that house and then transferred it to the Tiffany car. The berries went into the cars at about 50° F. The result was a complete success from the start. No such solid, good-keeping berries had ever been seen in Chicago. I enlarged this cooling house at Anna, built one at Villa Ridge, and another at Cobden. For several years we handled our own berries and other fruits and much that we bought with very good success. I think this first successful car was sent in 1872.

But I was never satisfied with these cars built for the dairy-product industry, which only carried about 1½ tons of ice. I wanted a car that could hold 5 tons of ice in its boxes (a cooling house on wheels), in which the fruit could be placed as packed, with the certainty that it would cool in transit and be safe for at least a three-day trip. After much canvassing among car builders, I finally secured a well-built, well-insulated car with this ice capacity. From this time forward the revolution in transportation methods was accomplished. We demonstrated by many shipments from Mississippi, Florida, and Georgia the complete adaptability and success of this system. Then we went to California and proved our ability to pick fully ripe and mellowing peaches in California orchards and lay them down in Chicago in perfect condition. This was done daily for a month, to the complete surprise of all the people in the trade and to the growers in California. The result has been a tenfold multiplication of crops of perishable fruits and vegetables, with their safe delivery in cool, sound condition to markets hundreds and thousands of miles distant.

The introduction of refrigerator transportation, as outlined in the above letter, was accomplished in the face of much skepticism and opposition. The early failures had made the trade skeptical, and the poor results obtained when overripe stock on the market was placed on ice to hold it over night or for a better price had given rise to a widespread belief that refrigerated goods, even if looking well on arrival, would not keep, but would melt down rapidly when taken off the ice. While this is unquestionably true of goods that are overripe before being placed on ice, it is not true of goods that are properly handled and are placed on ice while still fresh; but it required many conclusive demonstrations to convince the trade of this fact and to induce the average grower to risk his products in refrigerator cars. A Chicago firm, associated with Mr. Earle in his later refrigerator experiments, organized, with others, a fruit transportation company, with the control of a sufficient number of the above improved cars, with large ice capacity, to operate, not only from California, but from the more important of the Southern fruit and truck regions. This company was soon followed by others in the same field, and at the present day there are a number of responsible refrigerator transportation companies competing for the fruit and vegetable carrying trade. By making arrangements in advance, any community or individual can be sure of securing good, efficient refrigerator service. These companies usually send their own experienced agents to superintend the loading and icing of their cars.

Besides these Western experiments, refrigeration was slowly making its way in the East. The early use of ice boxes from Charleston and Florida has been mentioned. Later, in the early eighties, according to the Jacksonville (Fla.) Times-Union, a New York commission merchant leased some cars that he fitted up as refrigerators and ran in the Florida strawberry trade. In 1884, Mr. E. Bean, of Jacksonville, induced a Texas company to put their cars in the Florida trade.

### POINTS TO BE OBSERVED IN REFRIGERATOR SHIPMENTS OF TRUCK PRODUCE.

To secure the best results from refrigerator shipments it is necessary to carefully observe the following points: First, the goods must be handled and assorted with unusual care to see that no injured or overripe specimens are left with the sound ones. It is a great mistake to suppose that refrigeration will make good fruit or vegetables out of poor ones. True, it is possible to ship overripe fruits farther on ice than in an open car, but though they may look fairly well on arrival, such goods will soon go down when taken from the car, and will not prove satisfactory. It is high time for shippers of truck crops to understand that it is only the satisfied buyer who makes a permanent and profitable customer. The effect of refrigeration is simply to retard the natural processes of ripening and decay. If goods are on the point of decay it may temporarily arrest it, but it can not make the goods sound again. On the contrary, if the goods go into the car fresh from the field and in good condition, the changes that take place will be very slow, and they will come out at the end of three or four days, or even a week, in practically the same condition in which they went into the car. The second condition to secure success is, therefore, to get the goods into the car as quickly as possible after picking. A delay of even a few hours in hot weather may make a great difference in the condition on arrival. This is a vital point and one that is often overlooked by shippers. Third, the car selected must have good insulation to keep out the heat. The doors must fit tightly and manholes and ventilators of all kinds must be kept closed. The car should be made as nearly air-tight as possible. The ice boxes must have a capacity of at least 5 tons of ice, and they must be well filled before loading the car. The position of the ice boxes, whether at the ends or overhead, is of minor importance. Fourth, the load must be stowed as previously described for ventilated cars, so that there are continuous air passages both from bottom to top and from end to end.

It is even more important in air-tight cars than in ventilated cars to have this free circulation of air, and the circulation in a properly loaded car is very active. The air that is warmed by coming in contact with the hot goods at once rises to the top of the car, while that which has been cooled by contact with the ice flows in below to take its place. The hot air when it comes in contact with the ice is suddenly cooled, and in consequence loses much of its moisture, which is deposited on the ice. The load is therefore being constantly subjected to a current of cool, dry air. Refrigeration is thus essentially a drying process. The walls of the car are always dry enough to strike a match on them, since all surplus moisture is taken up and deposited on the ice. The hot load, as it goes into the car, melts out the ice very quickly. With the thermometer at 90° F. or above, the hot load will melt from 3 to 4 tons of ice during the first five or six hours. After that it melts much more slowly if the car is well insulated. This brings us to the fifth necessity, which is for frequent re-icing stations, so that the cars can be examined at least once in twenty-four or thirty-six hours and more ice added as needed. The first re-icing station should be not more than twelve hours from the shipping point. When this is not possible the car should, when loaded, be held a few hours at the shipping point and be re-iced before starting. This is important, even if it delays the shipment for twelve or even twenty-four hours.

Ventilated cars only are used for watermelons, as they do not ship well under refrigeration, but turn yellow more quickly than when in open cars. Ventilated cars are also used in shipping Southern potatoes. Strawberries may be safely shipped in open cars or by express to all points that can be reached the first morning after shipment. With entirely favorable conditions of weather and of the fruit, strawberries may be risked in this way to the second morning, but always with some risk of loss. In all cases it is safer to use refrigeration, if properly handled, when the fruit is to be out over twenty-four hours.

To recapitulate, then, the conditions for success with refrigerator cars are: First, good products carefully selected and packed; second, as little delay as possible in getting them from the field to the car; third, the car must have good insulation and a capacity for at least 5 tons of ice; fourth, the load must be so stowed as to secure a free circulation of air and prevent shifting of packages; fifth, re-icing stations must be provided at suitable intervals.

## MARKETING TRUCK PRODUCE.

### THE COMMISSION AND THE BUYING SYSTEMS.

It requires business ability of a high order to market truck crops successfully. It is by far the most important part of the business, for it is useless to grow good crops unless they can be sold at a profit; yet it is safe to say that there are ten men who grow good truck crops where there is one who markets them to the best possible advantage. In the early days of the business nearly all such crops were shipped on commission, and at the present time many of the more perishable crops are still mostly sold in this way. It has the advantage of giving the producer the full benefit of the market; but, on the other hand, he must assume all the risks of loss in transit and of temporary gluts, besides the very considerable risk of loss through dishonest agents, since by this system the commission merchant has things practically in his own hands.

If he is disposed to pocket the greater part of the proceeds and report the goods as arriving in "bad order," there is small chance for the shipper to prove the fraud. On the other hand, it is hard for the shipper to understand that the goods that left him in perfectly good order may have arrived in such a condition as to be almost worthless, and in very many cases dealers are accused of fraud when they have really sold the consignment to the best possible advantage and have remitted full value for it. Another drawback to commission shipments is that by this system it is almost impossible to get an even distribution of the goods to the different markets. If prices are high at one place to-day and low at another, the fact is telegraphed to all shipping centers, with the result that so many shipments are turned in the direction of the high prices that a glut ensues, while other points may be left with an insufficient supply. For the less perishable and somewhat standard goods, like potatoes and cabbage, the custom is getting to be more and more for the dealers to buy from the growers at the shipping point. The dealer thus assumes all risks of transportation and marketing, which is the more natural arrangement, and is on the whole much more satisfactory to both parties. True, the grower never gets quite such high prices as he occasionally secures by the other system, but he is protected from such frequent losses, and his average results are better. In some sections this system is being rapidly adopted for all kinds of products. This buying at the shipping point should always be encouraged by growers, for it insures them in the long run a more prosperous business. In only too many cases growers will refuse a good cash offer for their produce, and will take the risk of shipping. This has done much to discourage buying, for it has often been impossible for buyers to depend on getting a regular supply. Again, when a man is buying goods to be shipped to a certain market, some growers seem to think that it must be an unusually good one, and so will rush in large consigned shipments to compete with the purchased goods. The grower should recognize the fact that if the dealer comes to his town to buy his goods and assumes all chances of loss on them he must have a fair business chance and a margin of profit in order to afford the risks.

### AUCTION-SALE AND SHIPPING-ASSOCIATION SYSTEMS.

The California fruit shippers, realizing the drawbacks to selling on commission, some years ago inaugurated a system of auction sales in many of the large cities. This has been so successful that the great bulk of the fresh-fruit shipments from that State are now sold in this way. Cargoes of foreign fruits are also often disposed of at auction, but for some reason the system has been little taken up by the eastern produce shippers, though it has been much discussed, and seems to have some advantages. The shippers of eastern produce are so widely scattered that it has been impossible to unite them in giving this, or any other system requiring concerted action, a fair trial.

In a previous paragraph reference was made to the difficulty that confronted the isolated grower in loading cars and thus securing the lowest freight rates and the promptest service. The same difficulty confronted the smaller growers at large shipping centers, and to obviate it a form of shipping association was early devised by which all or a number of the shippers at any given point combine in loading cars. A loading and an unloading agent are appointed. The former receives the goods as they come from the farms, sees that they are properly loaded, makes out a manifest for each car, showing the number of packages from each shipper to each consignee, and bills the car to the unloading agent. The entire load thus goes as a single shipment to one consignee, though it may contain goods from a hundred shippers marked to one-fourth as many commission merchants. On the arrival of the car the unloading agent pays the freight and promptly unloads it, delivering the goods to the various commission houses, from whom he collects pro rata for the freight and the loading and unloading charges. The same unloading agent usually acts for a number of shipping associations, so that the charges are reduced to the minimum. This system has proved of great benefit to the smaller growers. It originated in southern Illinois and has extended to Tennessee, Mississippi, Arkansas, and Texas, and in a more or less modified form to other of the trucking centers.

A still further development of the shipping association idea has been attempted at some points. The growers have pooled their interests and load solid cars, which their shipping agent is empowered to either sell on track or consign as a whole to any market that from latest advices seems most desirable. In the hands of an efficient, well-posted agent this plan has many advantages. Such associations can secure rebates on commissions, and can afford to keep better posted on the markets than is possible for the small individual shipper. Such associations also have a distinct advantage in the matter of making direct sales. There is sometimes difficulty in securing suitable agents, and the plan has the further disadvantage that some growers are always more careless than others in packing and assorting their produce, while under this system it is impossible to distinguish between the careful and the careless in the returns, all having to share alike. This is an obvious injustice to the careful shipper and tends to put a premium on careless or dishonest packing.

### EFFORTS TO SECURE A JUDICIOUS DISTRIBUTION OF TRUCK PRODUCE.

Many devices have been tried for so controlling shipments as to secure a judicious distribution of perishable goods, thus avoiding the disastrous glutting of one market when perhaps some other one has an inadequate supply. Local, district, and even State associations have been formed with agencies for securing market reports, for superintending the distribution, and for diverting shipments from point to point as indicated by the latest telegraphic advices. Even when in competent hands and honestly administered these associations have not always been successful, since products are going forward at the same time from so many different competing sections that it has not been possible for them to keep posted as to the movement from the different points, especially as an unusually high price from any market generally attracts shipments from many quarters. Any plan that would really accomplish the result of avoiding gluts would be of untold good to the entire trucking interest, benefiting equally both growers and dealers. During the last few years an extensive experiment has been tried in the direction of a national organization for this purpose by the formation of the American Fruit Growers' Union. This is a regularly chartered company, of which any bona fide fruit grower may become a member by paying $1 as a 10 per cent payment on one share of the stock, the shares having a face value of $10 and being nonassessable. The members are required to pledge themselves to ship no fruit or produce on commission, but either to sell at the shipping point, which is always advised when such sale is possible, or through the regular accredited agents of the union. The central office is to be immediately informed by wire of the nature and destination of all shipments, and these are liable to be diverted to any other market than the one indicated by the shipper at the discretion of the central office. As the union is operating in all the principal shipping districts, it is able to keep thoroughly posted as to shipments, and thus divert its goods from points that are threatened with an oversupply. Theoretically, this is an almost perfect system of distribution; but if the union ever succeeds to such an extent as to be required to handle any very considerable percentage of the total produce shipments of the country, its central office will be confronted with a business so complicated and with responsibilities so heavy as to be fairly appalling.

So far, the friends of the union claim for it a very flattering measure of success, and it seems to be rapidly gaining in popularity. Its continued success will depend almost wholly on the ability of the central management. As the business increases, it will require alertness and business ability of the very highest order to avoid occasional mistakes that would give widespread dissatisfaction. It is proverbially hard to get produce shippers to combine, even when most obviously for their good, and they are always jealous of granting such absolute powers. The final result of this experiment will be watched with much interest, but those who have had most experience in similar attempts will understand best the difficulties in the way of achieving a lasting success.

### PACKING AND GRADING TRUCK PRODUCE.

The kind of packages used in handling the different truck crops varies greatly in the different trucking regions, and they are now in many cases very different from those that were used in the early days of the business. Thus, berries of all kinds were formerly marketed in heavy, shallow drawers, put up four or five together in stands. The berries were scooped up with a quart measure when sold at retail, and the empty packages were returned to the grower, to be used over and over. This answered fairly well for near-by markets, but the bulk of fruit massed together was too great for distant shipment, and the rehandling when sold caused it to reach the consumer in a bruised and bleeding condition. In the West the greater average distance for shipments early necessitated the adoption of some more suitable package. After many trials the cheap gift package made of thin veneer was devised which, in some of its forms, is now so universally used. In the East the inconvenience of return packages was endured much longer, but they have now almost or entirely disappeared. In fact, it would be utterly impossible to handle the present volume of business in any but gift packages. For berries, a quart, or sometimes a pint, box or basket is used, and these are packed in crates for shipment.

In the West the popular package for most tree fruits, tomatoes, and many other vegetables was for many years a rectangular box, holding one-third of a bushel, with sawn ends or heads, a middle piece 5 by 8 inches, and veneer sides 22 inches long. This package finally became discredited through the pernicious practice of placing the best specimens at the cracks and filling the middle of the box with culls. It is now comparatively but little used. There has been no greater drawback to the trucking industry than the various forms of dishonest or false packing, and it is indeed remarkable that growers will still be so shortsighted as to continue the practice when its evil effects are so well understood. In the East, particularly in the Peninsula region, an open slat basket holding about five-eighths of a bushel, has long been a popular package for tree fruits and many vegetables. It is a cheap package, and one in which the labor of packing is reduced to a minimum. In many ways it is very satisfactory, but for long shipments of the more delicate products it would be better if made broader and shallower. These open baskets require the cars to be shelved. In Michigan some form of flat, handled basket is largely used. In the South a light, 6-quart veneer basket packed in 4-basket or 6-basket crates is most used for tomatoes, peaches, etc. Beans, peas, cucumbers, and many other vegetables are packed in bushel crates.

In adopting a package it is always best to study the taste of the market it is proposed to supply and to conform to the prevailing usage. Buyers always prefer the package to which they are accustomed, and in most cases they will pay more for goods in what is considered a standard package than in one that is unusual.

Whatever the package, the greatest care should always be used in selecting and packing to make the goods as neat and attractive as possible and at the same time of uniform quality throughout the package. Only good, sound, honestly packed goods should be sent to market, and all culls should be rigorously thrown out and kept at home for stock feed. The average prices realized for truck products would thus be greatly improved, and one of the most annoying features of the business would be eliminated. A reputation for good packing is an asset of the greatest value to the truck shipper. When a brand is known to be reliable, the goods can often be sold in advance of arrival, and they will always sell quicker and for better prices upon reaching the market than unknown stock, the difference frequently being that between a good profit and an absolute loss.

# THE DATE PALM AND ITS CULTURE.

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## INTRODUCTION.

The date palm was one of the first plants to be cultivated, it having been grown for four thousand years along the Euphrates River. It has been for ages and is still the most important food plant of the great deserts, and many regions in Arabia and in the Sahara would not be habitable were it not for this plant. Not only does it yield a delicious fruit of great food value, but it also furnishes in many regions the only timber suitable for use in the construction of houses and for making a thousand and one necessary objects. Its leaves furnish a partial shade, under which it is possible to cultivate other fruit trees which could not exist were they exposed to the direct rays of the sun and the burning winds in the desert; thousands of fig, almond, pomegranate, and peach trees and grapevines, forming veritable orchards, are cultivated in the palm-covered oases, especially in the northern Sahara. For centuries the transport of dates has been the chief motive for the formation of the great caravan routes which run in every direction through the deserts in Africa and Arabia. The export of dates to Europe and to America has been and is still an important industry both in north Africa and in the countries bordering the Persian Gulf. The value of the dates imported into the United States alone averaged for the ten years ending June 30, 1900, $402,762 per annum, as appraised at the exporting point. The real value when received at the American port was doubtless 50 per cent greater, or $600,000 a year, an amount now exceeded only by the imports of two other dried fruits—Zante currants and Smyrna figs.

## WHAT IS THE DATE PALM?

The date palm, as its name indicates, belongs to the great family of palms. Like the majority of its relatives, it has but a single bud at the top of the trunk, and if this bud be destroyed the tree frequently dies. The date palm, however, unlike the cocoanut palm and unlike the majority of palms, produces offshoots, or "suckers," at the base of the stem (see fig. 58 and Pl. LIX, fig. 4), at least during the first decade of its existence. Old date palms which are in full bearing do not produce such offshoots, and if the terminal bud be destroyed the whole plant will die, since offshoots are never produced at the top of the trunk. The date palm, like most other members of this family, has a trunk which remains of the same diameter, no matter how old it may be, there being no secondary increase in diameter with increasing age such as occurs in ordinary fruit and forest trees. In consequence, the age of a palm tree can be roughly estimated from its height, but never from the diameter, nor, as is customary among woodsmen, by counting the rings of annual growth, for the simple reason that the date palm has no such rings.

The leaves of the date palm (fig. 57 and Pl. LIV) are feather-shaped and very large, frequently from 10 to 15 feet long. The ancient Egyptians had a tradition, held also by some tribes of modern Arabs, that the date palm produces twelve leaves in a year. It is an interesting fact that the earliest Egyptian hieroglyphic which signified a month represented a single leaf of the date palm, and the sign for year pictured a crown of leaves of the date palm. Of course, there is no such fixed interval of time between the unfolding of successive leaves, but it is true that the date palm usually produces from 12 to 20 leaves in a year.

These leaves remain alive and green for several years, but finally lose their color and bend downward toward the trunk. (See the lower leaves on the tallest palm in Pl. LIV.) Travelers who have seen date palms growing remote from human habitations in the Sahara Desert report that under such conditions the old leaves remain attached to the trunk permanently, the palm being crowned with living green leaves and the trunk clothed clear to the ground by the reflexed dead leaves. Furthermore, in such conditions, where the date palm is left to grow uncontrolled by man, the offshoots produced by the young palms grow unhindered and often rival in size the parent trunk, and they in turn give rise to other offshoots, even after the parent stem has passed the age when it would produce offshoots. The result of this is that instead of a single palm tree, the traveler sees a great thicket composed of a few tall trunks (the original palm and the oldest offshoots), surrounded at the base by a tangled mass of younger offshoots, struggling upward and outward. All of these trunks retain their dead leaves permanently, so that such a clump of palm shoots is well nigh impenetrable. Some suggestion of this manner of growth may be obtained from Pl. LIX, fig. 4, which shows a neglected palm tree. This tree, however, had been cared for previously, and does not give an adequate idea of the appearance of an entirely uncultivated date palm. To those who have traveled in countries where the date palm is the commonest cultivated tree, the description given above will seem very strange. In all such countries the date palm is well cared for and the dead leaves removed, leaving a clean trunk, crowned with a tuft of living leaves. (Pls. LIV, LV, and LX.) Besides this, the Arab cultivators are careful to remove the offshoots as soon as they are large enough to plant, or to destroy them when young in case they do not desire to propagate the variety. Such offshoots, ready to remove

Original Negative.

OLD DATE PALMS AT HERMOSILLO, NORTHERN MEXICO. ORANGE TREES AND ALFALFA IN THE FOREGROUND.

FIG. 1.—FIG TREES GROWING BENEATH DATE PALMS AT CHETMA, NEAR BISKRA, ALGERIA.

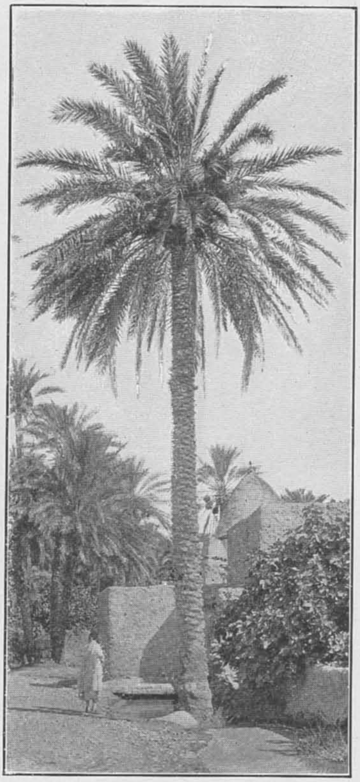


FIG. 2.—FIG TREES GROWING BENEATH DATE PALMS IN BISKRA, ALGERIA.

[Negative by Naudin, Paris.]

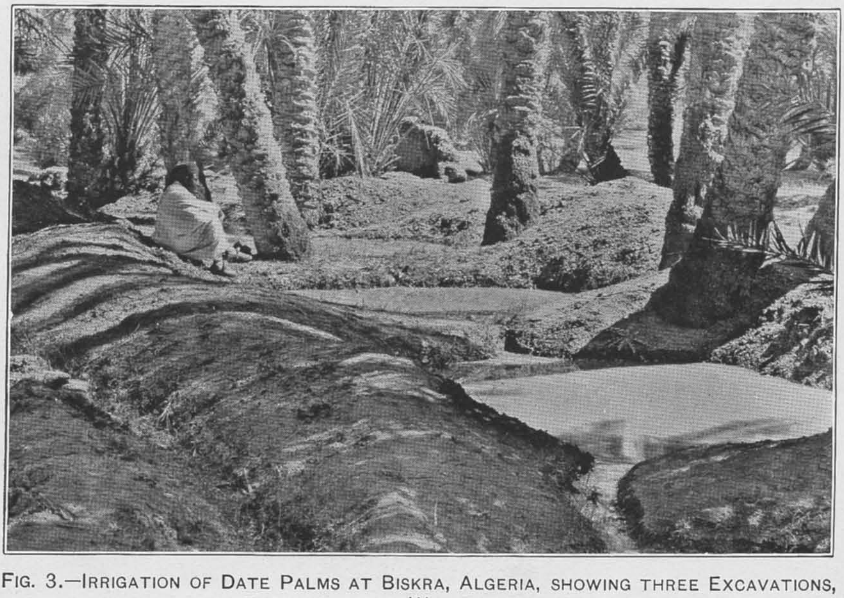


FIG. 3.—IRRIGATION OF DATE PALMS AT BISKRA, ALGERIA, SHOWING THREE EXCAVATIONS, THROUGH WHICH WATER IS FLOWING.

and plant, are shown by fig. 58 and offshoots removed and ready to transplant on Pl. LVI, fig. 1.

Unlike most of the ordinary fruit trees, the date palm has the male and female flower on separate individuals. If grown from seed, about half of the resulting palms are male and about half female. If such trees be allowed to grow to maturity in this proportion enough pollen is blown by the wind to fertilize all the flowers properly. It would be, however, a very expensive method of culture to irrigate and cultivate such a large proportion of male trees. The Arabs—and before them the Assyrians—learned to pollinate the palm artificially, and from a small proportion of male trees to fertilize the flowers of a very great number of female trees. At the present time the proportion followed in planting is that of about one male tree to a hundred female trees.

The date palm flowers in the early spring, producing from six to twenty flower clusters, according to the age and vigor of the tree. Each flower cluster on the female tree produces a bunch of dates, consisting of numerous fruits, borne on slender twigs, which branch from a main stalk (Pls. LVII, LVIII, and LX). Such a bunch may bear from 15 to 30 pounds of dates when ripe, and a vigorous tree is commonly allowed to produce from eight to twelve such bunches. The date itself is, of course, familiar to everyone; it is an oval fruit from 1 to 2½ inches long by half that width, containing a single seed surrounded by a half dry, and very sweet pulp, usually amber-colored. There are very many varieties of dates, differing widely as to character and quality, as will be explained more in detail further on.

### OUTLINE OF CLIMATIC REQUIREMENTS OF THE DATE PALM.

The date palm, although grown profitably only in arid and semiarid regions, is not in the proper sense of the word a desert plant, as are, for example, the cacti, or the creosote bushes, of the Southwest. It is entirely incapable of living on dry hillsides or arid mesas, which, nevertheless, support in Arizona and California a fairly abundant growth of shrubs, and even trees. The date palm demands a fairly abundant and, above all, a constant supply of water at the roots; at the same time, it delights in a perfectly dry and very hot climate. A well-known Arab proverb runs, "The date palm, the queen of trees, must have her feet in running water and her head in the burning sky." It is essential in order to avoid disappointment that these factors be kept in mind by all who attempt to cultivate date palms: First, the roots must have water; second, the leaves require a hot, dry atmosphere with abundant sunlight, if the plant is to mature dates of good quality. Another essential requirement of the tree is that the winters be not too cold. The date palm is able to stand much more cold than an orange tree, for example, but not so much as a peach tree, and probaby not even so much as a fig tree, which can sprout up from the roots if the twigs be killed by an unusually cold snap, whereas the date palm is usually killed if the terminal bud be frozen.

Great confusion exists in the minds of many in regard to the climatic requirements of the date palm, because the tree itself grows luxuriantly in many regions where it is useless to expect it to produce edible fruit. The tree thrives, for example, in Florida and in the West Indies, where the summer heat is too low and the humidity of the air too high to allow the fruit to ripen properly; in fact, in most humid regions the fruit would never ripen at all, but would spoil as it matured. In the Sahara no misfortune is more feared by the inhabitants than a heavy rain just as the fruit is ripening. Such a disaster may entail the loss of the entire crop if the rain be followed by a few days of cloudy and humid weather. It is, however, not enough that a region be destitute of rainfall to render it suitable for producing dates; there are many parts of the coast of California, especially in the southern part of the State, where the rainfall is very slight, or in some years almost entirely wanting, yet the date palm produces no fruit at all, or sets fruit irregularly and yields a very mediocre quality. This is doubtless due to two causes: First, the summer temperature is very much lower than it would be in a desert region remote from the cold sea breezes which here sweep over the coast lands nearly all the time when the sun is shining; second, these same sea breezes come laden with humidity, a condition distinctly unfavorable to the ripening of dates of a good quality. It is, then, essential that no one make the erroneous inference that because the date palm grows well in a region it may be cultivated there profitably as a fruit tree. As will be explained later on, the conditions under which the date palm bears good fruit, although highly peculiar, are now well known, and it is possible to predict in advance almost with certainty in what parts of the United States dates can be produced with a reasonable hope of profitable returns.

## DATE CULTURE BY THE ANCIENTS.

The date palm is one of the oldest cultivated plants. It is fully described on the clay tablets and carefully figured on the wall sculptures of the ancient Assyrians. It was undoubtedly one of their most important food plants, and every detail of its culture, the operation of pollinating the flowers, and even the serving of the fruit at the tables of the wealthy, was delineated with great accuracy on their monuments and wall sculptures. It is probable that the date palm was first extensively grown in the valley of the Euphrates. It was apparently little known and but slightly esteemed in ancient Egypt before 3000 B. C., although as early as 2000 B. C. it had already become a well-known fruit tree. Not much is known as to the origin of the date palm, although everything points to its being native in some of the canyons bordering the deserts of northern Africa or Arabia. It is probable that it was first cultivated by the Assyrians, afterwards by the Egyptians, and that very early its culture became almost a national industry with the Arabs. It is true that the date palm existed in ancient Africa before the arrival of the Arabs. It was, however, comparatively unimportant, and the varieties were probably inferior. When the Arabs invaded the western Sahara and the Barbary States during the seventh century, and at various intervals

FIG. 57.—Young Deglet noor palm, showing a fruit cluster still bound by the fiber used to attach male flowers in pollinating; also (to the left) a younger fruit cluster and a flower cluster just pollinated.

until the twelfth century, they introduced the use of the camel, and thereby rendered it possible for the inhabitants of the oases to satisfy ali their wants, simply by growing an abundance of dates, since the camels could carry the dates to the more fertile regions bordering the Mediterranean, where they could be exchanged for the wheat and barley needed in the Sahara for making bread. In consequence of this economic revolution, the culture of the date palm speedily became, and is still, the most important interest throughout the Sahara Desert.

The Moors undoubtedly introduced the date palm into Spain, and indirectly brought about its introduction into the New World, since the first dates in America were grown from seeds brought by the missionaries who accompanied the Spaniards on their voyages of discovery and conquest. The date palm does not succeed well in Spain, but during the Moorish occupation of the country it was nevertheless

FIG. 58.—Offshoots in place at base of palm: An Arab gardener is digging the semicircular ditches at the sides of the tree to hold water when irrigation is practiced.

extensively planted, and is still to be seen in many places, thougn it is now grown commercially only in a single oasis, Elche, in southeastern Spain, where the conditions of climate resemble very much those of the northern Sahara.

## HISTORY OF THE DATE PALM IN THE UNITED STATES.

The history of the introduction of the date palm into Southwestern United States may be summarized as follows:

First. The era of the Mission Fathers (eighteenth and early nineteenth centuries).

Second. The era of the American pioneers (1848–1880).

Third. The first trials of imported suckers (1876–1890).

Fourth. The importation of a representative collection of Saharan suckers (1899–1901).

### THE FOUR PERIODS OF DATE PALM INTRODUCTION.

The first planting of the date in California was probably by the friars (mostly Franciscan and Jesuit) by means of seeds doubtless obtained from the older missions in Mexico, which, when the missions were founded in the eighteenth and early in the nineteenth centuries, was controlled by Spain, and included all the Southwest. These date palms, now striking landmarks in southern California, are doubtless descendants of the older trees of Sonora (see Pl. LIV) and Lower California, and these in turn very probably sprang from the dates grown in Spain and brought out to the fields of their missionary labors by the far-sighted friars and padres. Unfortunately, all these dates—the Spanish, the Mexican, and the Californian—are of only mediocre quality, and are not to be compared to the choice sorts of the Sahara or Arabia, which are never propagated from seed, as those of Spanish origin always have been.

The second era in the introduction of the date palm was a result of the settlement of the Southwest by the Americans and its annexation after the Mexican war. The early American settlers planted the seeds of the dates they purchased, mostly from sutlers or purveyors of San Francisco, dates presumably imported from Busra (Bussorah) or Maskat on the Persian Gulf and of a quality much superior to those of Mexico. Splendid palms have grown from seeds planted in California and in Arizona in the sixties and seventies. These seedling dates grown by the American settlers are on the whole of better quality than those planted by the friars, probably because the seeds were obtained from a superior quality of fruit. In both of these epochs of introduction only seeds were planted, and in consequence, a large proportion (nearly half) of the resulting trees are male, and the remainder, though female, produce for the most part inferior dates, largely dry when ripe. Probably not more than one-eighth of the trees which issue from seeds produce soft dates of a flavor and texture suited to American tastes. Nevertheless, some few of these seedling dates are of excellent quality and represent the best dates as yet matured in the United States. (See Pl. LXI, fig. 1, and Pl. LXII, fig. 2.)

Unfortunately, some of the best seedling date palms planted by the American pioneers were allowed to reach maturity before their value was appreciated, and then it was too late to obtain offshoots by which alone it is possible to propagate a variety true to type.

The third epoch in the introduction of the date was inaugurated by the bringing in of a few rooted suckers from Egypt, Algeria, and Maskat. This was first attempted by Gen. Charles P. Stone in the seventies. He was then in the Khedivial army, and sent a few small offshoots of Egyptian sorts to southern California. These lived and grew, but unfortunately were afterwards allowed to die through the neglect of the property owners. A much larger importation was made by the Department of Agriculture through the Division of Pomology in 1889. Nine rooted suckers in tubs were imported from the Algerian Sahara, fifty-nine from Egypt, and six from Maskat. These offshoots were sent to New Mexico, Arizona, and California, but suffered many misfortunes. The most complete collection comprising sorts from all three regions was sent to Yuma, Ariz., only to be washed away and completely lost during the unprecedented flood of the Colorado River in 1891. Those sent to New Mexico were unable to stand the cold winters, and those sent to California suffered much from cold at the substations of the State experiment stations, while others sent to warmer regions were neglected by private growers to whom they were intrusted. (Pl. LXI, fig. 2.) However, one lot of these palms, comprising the Egyptian sorts, sent to the State experiment station at Phoenix, Ariz., grew well and fruited at an early age. (Pl. LXII, fig. 1.) It was, however, found that many of the offshoots from Egypt had been falsely named; many bearing the names of valued sorts proved to be ordinary males of no value. Some few female palms of fair quality were included in the shipment, however, and the successful fruiting of these proved the Arizona climate and soil to be suited to the culture of at least the Egyptian sorts. Prof. James W. Toumey first directed attention to the success of the date palm in central Arizona, as evidenced by the production of an abundance of fully matured dates by both the seedlings planted by American settlers and by offshoots imported by the Department of Agriculture. It was the success of these early importations of offshoots which rendered it desirable and feasible to undertake the recent large importations of offshoots made in 1899–1900.

The fourth epoch began with the organization of the Section of Seed and Plant Introduction in the Department of Agriculture in July, 1898. Attention was soon directed to the desirability of securing a large assortment of correctly named offshoots, particularly from the Algerian Sahara, whence are exported the best dates which reach Europe and America.

The University of Arizona and the Arizona Agricultural Experiment Station meanwhile offered to provide a special date garden, and to set out, irrigate, and cultivate the palms, if the Department of Agriculture would furnish a collection of offshoots of the best sorts of dates grown in the Old World. This offer was accepted, and in the winter and early spring of 1899 the writer visited, under instructions from the Secretary of Agriculture, the only successful date orchard near the Algerian coast (at Orléansville), and also the oases in the Sahara Desert about Biskra. A few offshoots were secured and forwarded as a trial shipment and a large number contracted for, to be delivered the following spring.

### PURCHASE OF DATE OFFSHOOTS IN THE SAHARA.

In May and June, 1900, the writer again visited Algeria for the purpose of shipping to Arizona the date offshoots previously contracted for and to purchase such additional plants of good sorts as could be

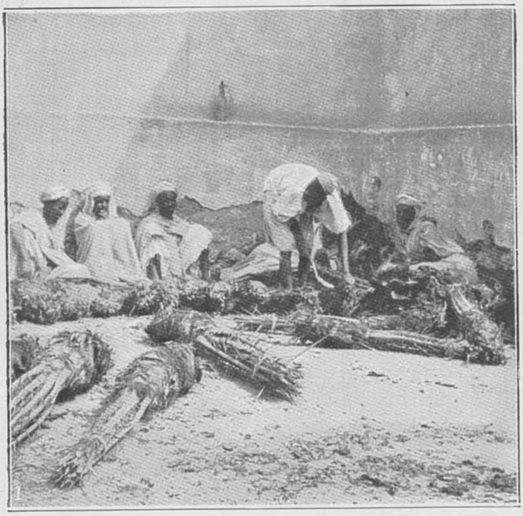


FIG. 1.—NATIVE GARDENERS (ROUARA) AT OURLANA, ALGERIA, PREPARING OFFSHOOTS FOR SHIPMENT TO ARIZONA.

FIG. 2.—OFFSHOOTS BEING PLACED IN SACKS PREPARATORY TO SHIPMENT.

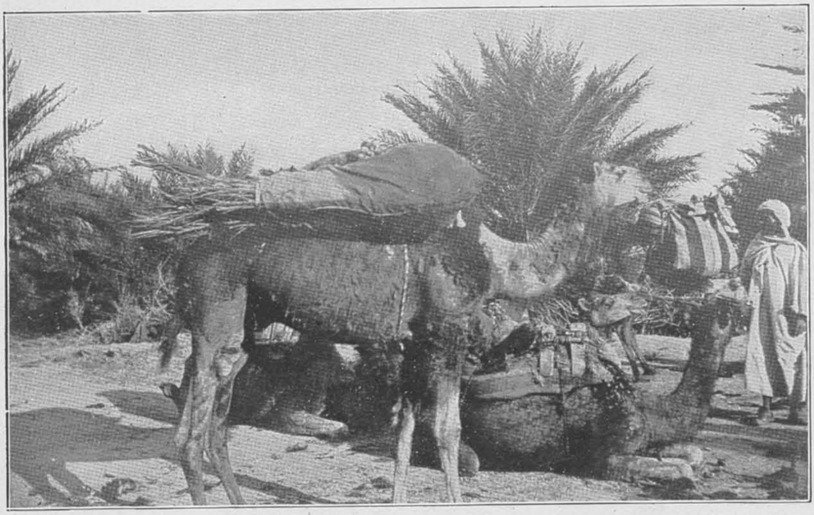


FIG. 3.—A CAMEL LOADED WITH TWO SACKS CONTAINING OFFSHOOTS.

[Negative by Charles Trabut.]

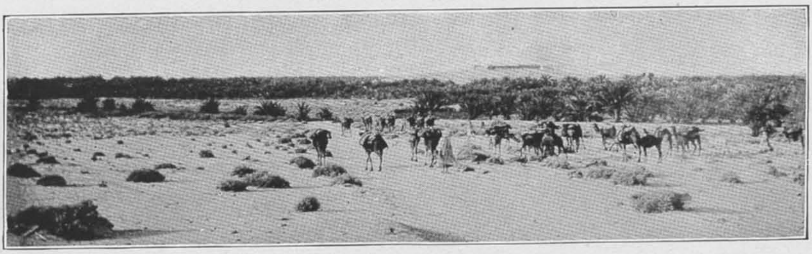


FIG. 4.—CARAVAN LOADED WITH DATE PALM OFFSHOOTS STARTING FROM OURLANA NORTHWARD TOWARD BISKRA, ALGERIA.

[Negative by Charles Trabut.]

had. In the latter part of May he arrived at Biskra, the present terminus of the East Algerian railroads, on the northern margin of the Sahara Desert, and just south of the foothills of the Atlas Mountains, which form the northern boundary of the Sahara. Here date culture is the principal industry; the oasis which contains the thrifty little city of Biskra has some 160,000 date palms (Pl. LX and Pl. LXI, fig. 5), and around this central oasis cluster a dozen smaller ones, all planted to the same palms. Altogether there are probably some 500,000 date palms in the group of oases surrounding Biskra. (See Pl. LIX, fig. 8, which shows a part of the palm forest of Chetma, one of the oases near Biskra.) Fortunately, it was also possible to visit some of the large plantations made by the French colonists in the Oued Rirh country, some 90 miles south of Biskra, situated at the margin of the great depression known as the Chott Melrirh, 30 to 75 feet below sea level. Here the summer heat is intense, and the famous Deglet noor, or "date of the light," comes to complete maturity. Tens of thousands of date palms have been planted in regular rows and irrigated systematically from the flowing artesian wells, which have enabled the French to reclaim hundreds of square miles of what was an absolute desert before their advent. Here at last were conditions approaching those obtaining in our own Southwest, inasmuch as the land was largely unoccupied when put under irrigation and the planting and irrigation was carried out by Europeans in accordance with modern horticultural methods.

Thanks to the courtesy of the president of one of the largest French companies interested in date culture and of the resident managers at Biskra every facility was afforded the writer, and he was enabled to study freely all the details of their methods of growing and marketing dates, especially about Chegga, M'raier, and Ourlana. Some suckers of the Deglet noor, which are rare at Biskra, and of some other sorts entirely unknown farther north, were purchased at Ourlana.

These offshoots were prepared for shipment by being wrapped in the fibrous material which is found between the bases of the leaf stalks and the trunk of the date palm, and which is called "leef" by the Arabs (Pl. LVI, fig. 1). This leef is porous and holds moisture fairly well. It was held in position at the base of the offshoots by stout cord. The offshoots were then placed by threes in bags, as shown in Pl. LVI, fig. 2, and then these bags were slung in pairs across the saddles of the camels (Pl. LVI, fig. 3). Finally, on May 19, 1900, the caravan (Pl. LVI, fig. 4) started on its journey to Biskra, some 90 miles northward, which was reached after two and one-half days. At Biskra many offshoots of the Rhars, probably the best early variety, and some few more of the Deglet noor were added to those obtained at Ourlana. Finally, after all the offshoots from the various oases had been collected together, labeled, and given a final soaking in water, they were piled into a specially chartered freight car and sent to Algiers, some 390 miles distant, where they arrived the first week in June. The offshoots were unloaded as soon as they arrived, and either placed in a tank of water, where they were allowed to remain a few hours, or else watered copiously. Meanwhile several other collections of date palms had been brought to Algiers for shipment. A valuable lot of Deglet noor palms, which had been grown a year in tubs, was donated by Prof. L. Trabut, Government Botanist of Algeria, and delivered free of all charges at the packing house at Algiers. Another collection consisted of offshoots which the writer had brought from the Sahara in the spring of 1899, and which had been planted in tubs at Algiers. A third and most important collection was that obtained from M. Yahia ben Kassem, a Mozabite proprietor, who, some years before had been decorated by the French Government for his services in introducing into the valley of the Chéliff River, in northern Algeria, a variety of date sufficiently early to mature its fruit during the rather short and relatively cool summer of the coastal region. This celebrated variety, the Tedalla, was obtained for trial in the interior valley region of California, where the earlier sorts are needed, and at the same time M. Yahia ben Kassem was requested to secure the other sorts grown in the M'Zab, the seat of the Mozabite civilization, located some 300 miles due south of Algiers and 200 miles southwest of Biskra. Although the oases in the M'Zab country are situated in the midst of a stony and unusually inhospitable desert, date culture has nevertheless been brought to a high degree of perfection, and the varieties obtained from this country, though little known even in other parts of the Sahara may prove to be of great value.

### PACKING THE OFFSHOOTS FOR SHIPMENT TO NEW YORK.

A trial shipment of date offshoots in tubs, made in the spring of 1899, showed this to be a most expensive and at the same time unsatisfactory method, and in 1900 the writer concluded to abandon all attempts to ship the offshoots in this manner, even where they had grown a year in the tubs and had become well rooted. Of course, the offshoots recently cut from the parent trees were entirely without roots, and it would have been useless to put these in tubs in order to ship them. It was difficult to decide how best to pack the offshoots for shipment, since there was no experience available as a guide except as to shipments in tubs, which method had been followed by the French and British Governments in shipping Algerian palms to South Australia, in spite of the very great expense involved. It was finally decided to pack all offshoots in wooden boxes, which could be shipped at ordinary rates, avoiding the exorbitant charges demanded for tubs containing living plants. The offshoots were trimmed as much as possible, and the envelope of palm fiber wrapped around those brought from Ourlana was removed. Then a covering was made of long grass or strips of banana leafstalks, and in the center of this was placed a double handful of moist moss, or sphagnum, mixed with coir powder (a by-product obtained in preparing coir fiber from cocoanut husks). The moss was packed well about the base of the offshoots where roots would sprout, or, in case of offshoots grown a year in tubs, about the roots themselves, which had been freed from the earth; then the envelope of grass, or banana leaves, was drawn up and tied securely around the offshoots in order to hold the moss in place. After this the offshoots were packed in wooden boxes some 4 to 6 feet long by from 2 to 3 feet square. In all there were some 23 cases, weighing 8 tons, and measuring 21 cubic yards. They were shipped from Algeria on June 13, and reached New York July 3, where the boxes were examined

FIG. 59.—View of palm garden at Tempe, Ariz., showing plants imported from the Algerian Sahara in 1900. A workman is just planting an offshoot. (From negative by Prof. R. H. Forbes, August, 1900.)

and found to be in good order, and were at once forwarded to Arizona via New Orleans. The Southern Pacific Railway Company and the Morgan Steamship Line had generously offered free transportation for the entire shipment, and thanks to special orders given to expedite transit, the freight car containing the boxes reached Arizona about three days after the steamer delivered the freight in New Orleans, an exceptionally rapid journey. On July 17 the palms reached the siding adjoining the palm garden at Tempe, in the Salt River Valley, and were unloaded at once by Prof. R. H. Forbes, director of the Arizona experiment station, who superintended the entire unpacking, disinfection, planting, and irrigation of the palms in accordance with the agreement made between the Department of Agriculture and the University of Arizona. By July 20 all were unpacked. On the 20th and 21st all the offshoots were fumigated with hydrocyanic-acid gas to destroy any insect pests that might have been brought with the palms from Algeria. On July 21 the offshoots were soaked in water flowing through the irrigating ditches and were kept moist afterward until the planting was finished on July 25. The offshoots were then planted, some 20 and others 30 feet apart (see fig. 59). Professor Forbes reports that "an inspection October 2 showed 93 per cent of the plants to be apparently safe, and some of them were beginning to grow." Two

FIG. 60.—Arabs demonstrating method of pollinating date flowers. The cluster of female flowers has been removed from the sheath and a twig of male flowers inserted, which will be tied in place with the fiber held by one of the Arabs in his mouth.

cases, containing 35 offshoots of the Rhars variety, after being fumigated, were sent to California to be distributed in cooperation with the University of California.

This shipment, which was the largest ever sent from North Africa, included altogether 447 offshoots, comprising some 27 varieties. Of these, 391 were planted in the cooperative garden at Tempe, together with 6 offshoots sent in the spring of 1899. Fig. 59 shows a part of the date garden where the offshoots were being planted. Twenty-one were planted at the Arizona experiment station farm at Phoenix, likewise in the Salt River Valley, along with the 9 Egyptian date palms received in 1890, and, as before mentioned, 35 were sent to California, part to Pomona and part to Berkeley.

## WHAT THE DATE PALM REQUIRES IN ORDER TO GROW AND TO FRUIT SUCCESSFULLY.

### HEAT.

As has been stated, the date palm differs widely from ordinary fruit trees in its requirements as to its climate and water supply. In this, indeed, it is almost unique, there being even in the Sahara and Arabian deserts, which have been cultivated for thousands of years, no other fruit trees whose requirements are like those of the date palm. The most necessary condition for the growth and fruiting of the date palm is that it receive an abundant supply of heat. It is able to endure a considerable amount of cold in winter, much more than the orange, for example, but requires a very hot summer in order to mature its fruit. From a study of the climatic conditions in the various regions where the date is grown, as well as in regions where its culture has not proved successful, one can deduce with a fair degree of certainty the temperature at which the date palm is injured in winter and also the degree of heat which is necessary for it in summer. It is probable that in a dormant condition it is seldom injured by temperatures above 20° F., and is able to live through winter in regions where the temperature occasionally falls as low as 15° F. Commonly, however, date palms are severely injured by temperatures as low as this, frequently losing most of their leaves. The amount of injury they suffer is partly dependent upon their condition at the time when they are exposed to the cold. If entirely dormant they are much less injured than if some of the leaves have only recently unfolded or are still growing. It should further be noted that young date palms are much more likely to be injured by cold than are old ones. This, no doubt, is in part because the young plants are more sensitive to cold, but doubtless largely because the growing leaves, with their inclosed bud, are much nearer the ground than on an old tree, and would therefore be exposed to lower temperatures than the buds of old palms growing far above the surface. Old and vigorous trees might perhaps occasionally weather cold snaps where the temperature fell below 15° F., provided such were exceptional and occurred only at intervals of many years. We might then set practically four different limits below which palms would be injured by cold: (1) Young palms in active growth would be liable to injury if the temperature fell below freezing; (2) young plants not in active growth and old palms if nearly dormant would be severely injured only by temperatures falling below 20° F.; (3) old and dormant trees would be severely injured only by temperatures below 15° F.; (4) most date palms would be killed and all would be seriously injured by the temperature falling below 10°, and date culture would be impossible in regions where such temperatures occurred more than once in a decade. These considerations show that the date palm has about as much resistance to cold as the fig tree, for example, with this important difference—that a fig tree is able to recover and grow again the next year, even if it be frozen to the ground by severe cold in winter. With the date palm this is not possible, since, if the growing bud of an old tree be killed, it is impossible for the trunk to sprout out again.

FIG. 61.—Wolfskill dates grown at Winters, Cal.

The date palm requires an enormous amount of heat in order to ripen its fruit properly. The tree itself is able to grow fairly well in many regions entirely too cold to allow the fruit to mature. This has been the cause of many misunderstandings as to the climatic requirements of the date palm, and it has often been proposed, and in some countries it has been attempted, to grow the date palm in regions where the amount of heat was totally inadequate to ripen fruit. It becomes, then, a matter of some importance to determine how much heat is required for dates to mature. From a comparative study of the records of many regions where the date palm has been grown, it is pretty clear that unless the summer climate is what would be commonly termed extremely hot, there is little or no chance of fruiting the date palm successfully. There is little hope of growing even early sorts unless the mean temperature in the shade goes above 80° F. for at least one month in summer, and the mean temperature of the fruiting season, from May to October, is above 70° F. It is further fairly certain that during the months when the fruit is developing, viz, May to October, inclusive, the mean temperature must be about 75° F., and during June, July, and August above 80°, if moderately late varieties of dates are to be brought to maturity. In regions where late varieties of dates come to maturity the mean temperature for June, July, and August must be 90°, or thereabouts. As a matter of fact, temperatures very much higher than 90° are necessary in order that the date may properly mature; but, of course, the leaves of the date palm are exposed to the rays of the sun and become much hotter than thermometers kept in the shade. Temperature records would have to be made from thermometers exposed to the sun in order to determine accurately the temperatures necessary for the maturation of the fruit. It has been found, for example, that the sum of the daily maximum temperatures during the growing season gives a better idea of the adaptability of the climate for the date than does the sum of the mean temperatures, which latter is commonly used by

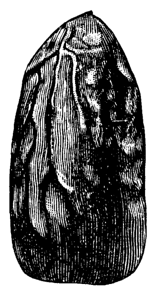


FIG. 62.—A Bennet date, from Phoenix, Ariz.

climatologists and botanists in determining the amount of heat required by plants. It is pretty clear that the date palm is unaffected, so far as flowering and fruiting is concerned, by temperatures below 64.4° F. (18° C.). Taking this as the zero point, the sum of the daily maximum temperatures for the months from May to October, inclusive, is found to amount to above 3,500° for stations like Fresno, where the early varieties of the date palm are just able to mature, and amounts to about 5,500° at Phoenix, Ariz., and Biskra, Algeria, where ordinary varieties ripen well and even late varieties usually reach maturity. At Tougourt, in the interior of the Sahara Desert, where the Deglet

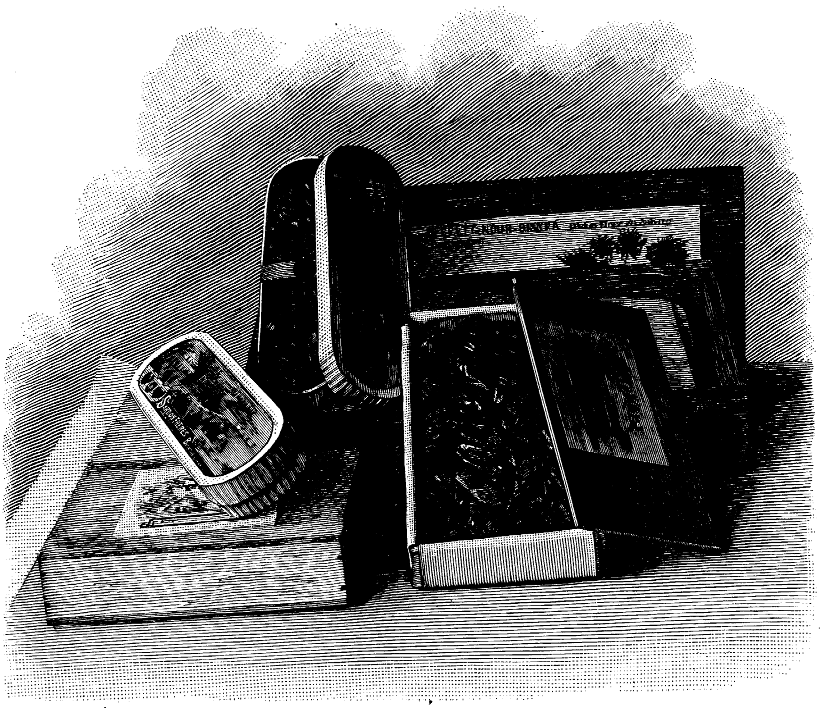


FIG. 63.—Deglet noor dates from the Algerian Sahara, showing methods of packing for retail trade.

noor date reaches full perfection, the sum of the daily maximum temperatures for the same period amounts to over 6,500° F. No records are as yet available from which the sum of the maximum temperatures occurring in the hottest parts of the Colorado Desert could be calculated, but it is probable that places like Salton and Volcano Springs would show a sum of heat comparable to that recorded at Tougourt.

A peculiarity of climate, which is of considerable importance in deciding which are the best localities for planting date palms, is the remarkable inversion of temperature which occurs in many parts of

Arizona and California, more especially in the arid hot regions, where the date palm thrives best. For example, in Arizona the winters are mild enough to permit date palms to be grown at an altitude of nearly 5,000 feet and even as high as 6,942 feet at Supai. It is, however, noticeable that points very much lower frequently show temperatures sufficiently low to injure severely or kill date palms. For instance, at San Carlos, which, at an altitude of 2,456 feet, and at Tucson, at the university weather station, at an altitude of 2,230 feet, the temperature fell to 11° F. in 1891, while at Dragoon Summit, at about 4,611 feet altitude, some 60 miles to the east of Tucson and 80 miles southwest of San Carlos, the temperature is not recorded even as low as 15° F.[1] In January, 1891, the temperature did not fall below 32° F. at Dragoon Summit, while at Wilcox, only 20 miles northeast, and nearly 500 feet lower, the temperature fell to 9° F. A still more striking example is shown by a comparison of the temperatures at Parker, on the Colorado River, at an altitude of about 500 feet, and at Supai, nearly 7,000 feet above sea level, some 120 miles to the northeast. In the winter of 1899 and 1900 the temperature did not fall below 26° F. at Supai, while the imperfect record at Parker shows a minimum of 23° F., that is to say, that although Supai is nearly 6,500 feet higher than Parker, and is about 65 miles farther north, the minimum temperature was actually higher at Supai in winter. Numerous similar instances could be cited in California and in the "thermal belt" along the foothills of the Sierra Nevada Mountains, adjoining the interior valley region, where occur some of the most striking instances of temperature inversion known.

All these anomalies can be explained by means of the principle of the inversion of temperature, a phenomenon which occurs especially in arid regions. During the night, when the air next the ground is cooled rapidly by radiation unhindered by clouds, this cold air flows from the higher points just as water would, and drains down into the valleys. As the cold air flows into the plains it doubtless tends to flow under and to lift up the warm air, and finally, as a result, all elevated points where there is a good drainage of air show relatively high temperatures during the night, while points located in the valley floor frequently show very low temperatures, constituting an exception to the general rule that the lower the altitude is the higher is the temperature. It will frequently be possible to grow date palms along the foothills where it would be impossible for them to succeed in the plains a few hundred feet below.

However, high summer temperatures are essential to the proper fruiting of the date palm, and the upper limit in altitude of its culture

[1] All the data as to temperature and other meteorological phenomena at the various points named in the United States are from the reports of the Weather Bureau and of the State weather services of California, Arizona, New Mexico, and Texas.

is likely to be set by the insufficient heat of summer rather than because of the severity of cold in winter. At points situated at high altitudes, whence there is a good drainage of air, the fluctuations of temperature are less than in the plains below, and consequently the winters are warmer and the summers are cooler. In order to grow date palms at high altitudes, it will usually be necessary to search for canyons or ravines with a southern exposure, where the air is heated by reflection from mountain cliffs as well as by direct insolation.

### RELATION OF HUMIDITY TO THE FRUITING OF THE DATE PALM.

The leaves of the date palm show very important adaptations in their structure to prevent their being injured by the hot and dry winds of the desert, so there can be little doubt that the plant is especially fitted for growth in arid regions. It grows fairly well in humid regions, but does not mature its fruit properly unless the air be very dry. It is not sufficient that a region have no considerable rainfall in summer if it be exposed to the moisture of the winds from the ocean, as is, for example, the coast of southern California. Here the effect is doubtless not due wholly to the humidity of these winds, as they are also cold and may prevent dates from ripening by keeping the temperature too low. There is, however, abundant evidence for believing that a very dry atmosphere distinctly favors the production of dates of a high quality, and the best dates are grown in the hottest and driest regions, located at some distance from the sea or from any other considerable body of water. The ripening dates are very likely to be injured by a heavy fall of rain, especially if it be followed by a few days of cloudy and humid weather. Such rains have been known to ruin almost entire crops of dates in the western Sahara. The abundant rains which occur in late summer and in autumn in regions such as Florida, for example, preclude the possibility of successful date culture there, even if the amount of heat received in summer were sufficient to mature the fruit, which it probably is not.

### WATER SUPPLY REQUISITE FOR DATE CULTURE.

The date palm, as has been stated, is not a desert plant in the ordinary sense of the term, that is, it is not able to grow in very arid climates where the soil also is very dry. Its leaves are adapted to withstand the driest climates, but the roots must have a constant supply of moisture, or else the tree will die. It is probable that the date palm was native in the beds of ravines or canyons which drain into the sterile plains of the Saharan or Arabian deserts. Streams doubtless flowed down these ravines after the rare downpours of rain, and there was a continuous supply of water not very far below the surface, even during the driest seasons. Certain it is, that the date palm is entirely incapable of growing in situations where cacti, yuccas, and many other desert plants thrive. It is a very interesting fact that the date seed is adapted to germinate in very moist situations, and the young seedlings even show adaptations for getting rid of superfluous moisture taken up by the roots. These interesting peculiarities are another proof that the date palm could never establish itself except in locations where the soil occasionally gets very wet and remains moist even on the surface for some weeks at least.

The amount of water required by the date palm will be treated more in detail under the topic of irrigation. It may be noted here that it does not demand a large amount of water, but rather a constant supply.

### RESISTANCE OF THE DATE PALM TO UNFAVORABLE CLIMATIC AND SOIL CONDITIONS.

As has already been brought out, the date palm requires certain unusual climatic and soil conditions in order to thrive, and in consequence of these prerequisites its culture can be profitably engaged in only in a very few regions within the limits of the United States. On the other hand, it has wonderful powers of resistance to certain climatic and soil conditions which are distinctly injurious to most forms of useful vegetation. In the first place, the date palm is not only uninjured by excessive dryness of the air, such as would preclude the growth of many plants having more succulent leaves, but is distinctly favored by intense sunshine, and does not endure being shaded; the hotter the air the better the quality of dates produced. In fact, a long and excessively hot summer is necessary to produce the best quality of dates. Climates so hot and dry as to be unsuited to ordinary fruit trees are admirably adapted to this plant. It is furthermore able to endure without injury the enormous fluctuations of temperature which occur in hot arid regions. The date palm is able to endure a considerable amount of cold, and when in a dormant condition is entirely uninjured by temperatures 10° to 12° below the freezing point.

Most important of all, the date palm is able to thrive on soils so alkaline as to be useless for the culture of all ordinary trees and crops. It is this remarkable ability to resist alkali and to thrive when irrigated with brackish water which constitutes one of its greatest advantages over other kinds of fruit trees for culture in arid regions. Were it not for the fact that the date palm requires so much heat in summer, and is injured by temperatures below 20° in winter, it would doubtless soon be planted on all the alkali lands throughout the United States. Even now it is one of the most promising plants for culture on alkali lands in Arizona and California. It has been claimed by some that the date palm is actually favored by the presence of alkali in the soil or in the water used in irrigation. There is, however, but little evidence for this view, and it is probable that the tree not only grows better, but is more fruitful if grown on good land and irrigated with fresh water. Its powers of resistance, however, are so enormous that it flourishes in lands covered with a crust of alkali, even when it is watered by brine so strong as to kill most cultivated plants.

### IRRIGATION OF THE DATE PALM.

As before noted, the date palm requires that the earth be kept constantly moist about the roots, and therefore needs a continuous supply of water. It does not, however, need as much water as ordinary fruit trees growing in the same situations. M. Jus, the celebrated French engineer, who has done so much to reclaim the northern Sahara by a study of the artesian water supply there, considers that each palm tree requires one-third of a liter (0.35 quart) per minute at the flowing well or main irrigating canal, and palms which receive from 0.4 to 0.5 of a liter (0.42 to 0.53 quart) per minute are more vigorous and yield more fruit even if crops are grown underneath. If each tree receives 0.35 quart per minute this would amount to 126 gallons per day, or about 17 cubic feet. At one pint per minute the daily consumption would be 180 gallons, or a little more than 24 cubic feet. These data are not for the amount of water actually furnished the trees, but for the amount which must be allowed for each tree at the head of the principal irrigating canals. Of course, some of the water is lost by evaporation and seepage before it reaches the palms. Another recent statement as to the amount of water considered necessary for a date palm in the Algerian Sahara gives the requirement as 72 cubic meters (19,021 gallons) in twenty-four irrigations of 3 cubic meters (792.5 gallons) each. Of these irrigations, seventeen irrigations, or, in all, 13,473 gallons, are given during the hot season from June to September, inclusive (122 days), two irrigations during autumn and winter, and five in spring. In order to calculate how many palms can be irrigated by a given flow of artesian water, it is necessary to consider primarily the amount the trees will need during the hot season, when the quantity of water demanded is much greater than in winter. As just stated, this amounts to 13,473 gallons for four months, or about 110 gallons per day, which is a little less than the amount considered necessary by M. Jus.

It must be remembered that the figures given above are for the western Sahara, a region noted for its extreme dryness, where the evaporation from a free surface of water often averages more than one-half inch per day during the four summer months. It is probable that a smaller amount of water would suffice in regions where the air is not so dry and consequently where the evaporation is less.

Where no crops are grown under the date palms it is customary to irrigate them by means of trenches excavated alongside of the trees, which are occasionally filled with water (see fig. 58 and Pl. LV, fig. 2). Where such crops as barley or alfalfa are grown under the trees, it is customary to divide the land up into small beds from 10 to 30 feet in diameter, which are surrounded by a raised rim. When irrigated the whole bed is flooded, the water being retained by the surrounding ridge. A larger amount of water is required when applied in this manner than would be if poured into a trench at the side of the palm.

It has been found important to provide good drainage, especially when the date palms are planted where the soil and water is alkaline. The French colonists have usually accomplished this by digging open trenches between every two rows of date palms, that is, running parallel at distances of about 50 feet apart. Doubtless, underdrainage by means of tile would prove to be still better. It is an interesting fact that the drainage water, even from the very alkaline lands, can, nevertheless, be used again for irrigating date palms, rendering it probable that the beneficial effect observed after drainage is due, in part at least, to the aeration of the subsoil.

The palm tree will grow in regions where there is standing water a few feet below the surface without requiring to be irrigated by surface-flowing water. Such unirrigated palms are shown on Pl. LIX, fig. 7, but even in such regions it is customary to water the palms occasionally by means of water raised from shallow wells with sweeps. (Pl. LXI, fig. 6.) There are in the Salt River Valley and elsewhere in the Southwest considerable areas underlaid with water which drains from the irrigated lands situated higher up. Such areas commonly become impregnated with alkali and are known as alkali spots. The date palm is more likely to succeed on such lands than is any other fruit tree, but it is not probable that it will succeed as well as when planted where it is possible to aerate the subsoil by means of irrigation with water that flows in open ditches and where there is a good underdrainage.

At the San Joaquin Valley substation of the California experiment station at Tulare it has been found that if the palms are irrigated in the late summer they are forced into growth and are likely to be injured by cold during the following winter. It is recommended at Tulare that no irrigation be practiced later than June. This recommendation deserves attention wherever it is attempted to grow date palms where they are exposed to severe cold in winter.

## PLANTING, CULTIVATING, AND FERTILIZING DATE PALMS.

### PLANTING AND CULTIVATING.

The Arabs almost invariably plant the date palm without any attempt at placing the young offshoots in any definite order. The result is, it is almost impossible for them to be sure of planting the trees at any constant distance from each other, some being close together, others wide apart, as can be seen in Pl. LV, figs. 1 and 2, and Pl. LXI, fig. 4.

The unsystematic and frequently careless methods employed by the

Arabs in the culture of the date palm can not be taken as models to be followed in introducing the date industry into the Southwest; we should rather follow the example of the French colonists who plant the date palm in regular rows, and have, as a rule, definitely planned and carefully executed systems of irrigation and drainage. Although the Arabs plant the date palms very close together, the French have found it advisable to place the trees wide apart, and many of the French colonists regret having placed the trees only 20 or 25 feet apart, their opinion now being that date palms should be planted at least 30 feet from each other. When planted so wide apart there are, of course, large strips which lie unused between the palm trees for the first ten or twelve years after planting. It has become a common practice, copying to some extent after the Arabs, to plant garden or field crops between the trees until the palm trees become large enough to shade the ground. In case the soil is alkaline, it is frequently impossible to grow any crop until two or three years of abundant irrigations, coupled with a good system of drainage, have washed the alkali out of at least the top layers of the soil. Barley is usually the first crop grown on alkaline soil. After barley has been grown a year or two, the abundant irrigation being, of course, kept up, the land usually becomes freed from alkali sufficiently to permit horse beans, cowpeas, beets, and other garden crops, and, what is of more importance, alfalfa to be grown. This oasis alfalfa, although refusing to grow on soil which produces a fair crop of barley is, nevertheless, able to support without injury a percentage of alkali in the soil which would prevent the growth of ordinary alfalfa.

PROPORTION OF MALE TREES THAT SHOULD BE PLANTED.

It has been found in the date plantations of the Sahara that for every hundred date palms there should be one male tree to furnish pollen for use in fertilizing the flower clusters in spring. There are already a large number of male date palms in Arizona and California, so that it has not been thought necessary to introduce more than a very few male palms from the Old World. The ratio of one male palm for every hundred female applies only in the Sahara where it is possible to secure male palms known to flower at the right time to be used in pollinating. It often happens that many of the male plants flower too late to be of any use. It does not interfere with the usefulness of a male date palm to have it bloom too early, since the bunch of male flowers can be preserved for some weeks without serious deterioration. Out of six date palms which had bloomed up to 1898 at the San Joaquin Valley substation of the California experiment station, three were female and three male, but two of the three male palms did not flower until the female trees had ceased blooming. In view of these facts it will be advisable in starting any plantations to put out at least one male palm for every fifty females, or better, one male for every twenty-five females. It will be desirable also to secure offshoots from different male trees in order to avoid getting male trees all of one kind, which might be found to bloom at the wrong season. When the trees begin to flower it will be possible to see readily which male trees bloom at the right season; the others can be destroyed and offshoots from female trees planted in their places.

### FERTILIZING.

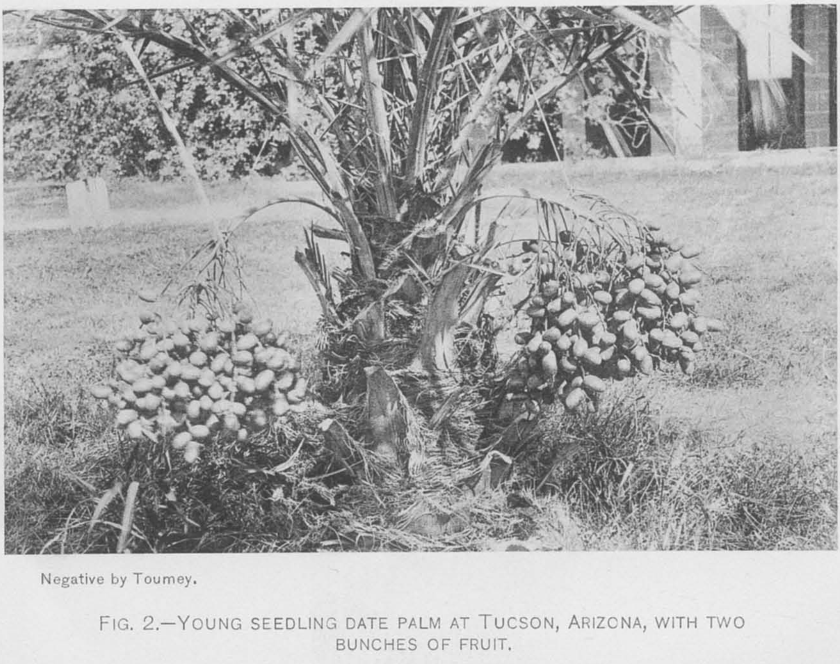
The leguminous plants, such as the alfalfa, horse bean, cowpea, and others, are undoubtedly of great importance in attempting to carry on extensive date culture, since these plants are able to fix the free nitrogen of the air and to store it up in their root systems as well as in the leaves and seeds, so that even where the crops are not plowed under it is nevertheless probable that the growth of such plants actually increases the fertility of the soil through the decay of their root systems, which is followed by a setting free of the nitrogen compounds that have been stored up during growth. This question of how best to fertilize the soil on which the date palms grow is one of great importance, and has not yet been adequately worked out, even in the Algerian Sahara. As long as the Arabs had merely small gardens, in which, as a rule, they lived and quartered their goats and camels, it was possible to fertilize the palm trees with stable manure and night soil, or to purchase enough manure from the owners of large herds of camels. In the large French plantations, which often cover a hundred acres or more, and where very few domestic animals are employed, it has been found impossible to secure an adequate supply of manure, and in order to keep the trees in a condition permitting abundant and continued fruit bearing it is probable that recourse must be had to commercial fertilizers, or, better still, to some proper system of culture whereby soiling crops, and especially leguminous plants, are plowed under and thereby fertilize the soil. It is true that it is commonly asserted that the date palm does not require a fertile soil, and in one sense this statement is correct; but it will soon be found that unless the soil is fairly fertile the yield of fruit is both uncertain and small in amount. It is unquestionably true that dates produced on trees grown in a well-fertilized soil are of superior quality to those produced by neglected trees growing in sterile sand.

### THE DATE PALM AS A SHELTER FOR FRUIT TREES.

In many parts of the northern Sahara the date palm is almost as important as a shelter and partial shade for fruit trees as it is for its own fruit. At the time of the Roman occupation of Africa these oases were largely planted to olive trees, some of which, indeed, still remain—giant stems 1,500 or 2,000 years old. It happens that the olive is about the only other fruit tree which is able to stand without

Negative by Toumey.

FIG. 1.—EIGHT-YEAR OLD SEEDLING DATE PALM AT PHŒNIX, ARIZONA, BEARING SEVENTEEN BUNCHES, ABOUT 400 POUNDS, OF DATES.



Negative by Toumey.

FIG. 2.—YOUNG SEEDLING DATE PALM AT TUCSON, ARIZONA, WITH TWO BUNCHES OF FRUIT.

injury the fierce heat, intense light, and the driving sand storms of the Sahara, and even the olive itself grows better and yields more fruit if planted under the protecting shelter of the date palm. Most other fruit trees, such as the apricot, peach, almond, pomegranate, fig, and jujube, can be grown successfully in the Sahara only in the shade of other trees, and do best where grown under the date palm. In the northernmost oases of the Sahara the dates are frequently of inferior quality, whereas the fruit trees do better than in the hotter and dryer regions farther south. Many of these northern oases have veritable orchards growing under the half shade furnished by the crown of slender leaves of the date palms far above. This is well shown in Pl. LV, figs. 1 and 2, which represent fig orchards growing under date palms at Chetma and Biskra. It sometimes happens that vegetables are grown under the fruit trees, in which case it is possible to see three crops occupying the soil—first, the date palm, towering far above; then the fruit trees, and under them the more delicate and shade-loving garden vegetables. It is not at all impossible that in some parts of our own Southwest the date palm may prove very useful in the manner above described, serving as a shelter and partial shade to more delicate fruit trees which thrive perfectly in regions too cold to allow of the culture of the best sorts of dates.

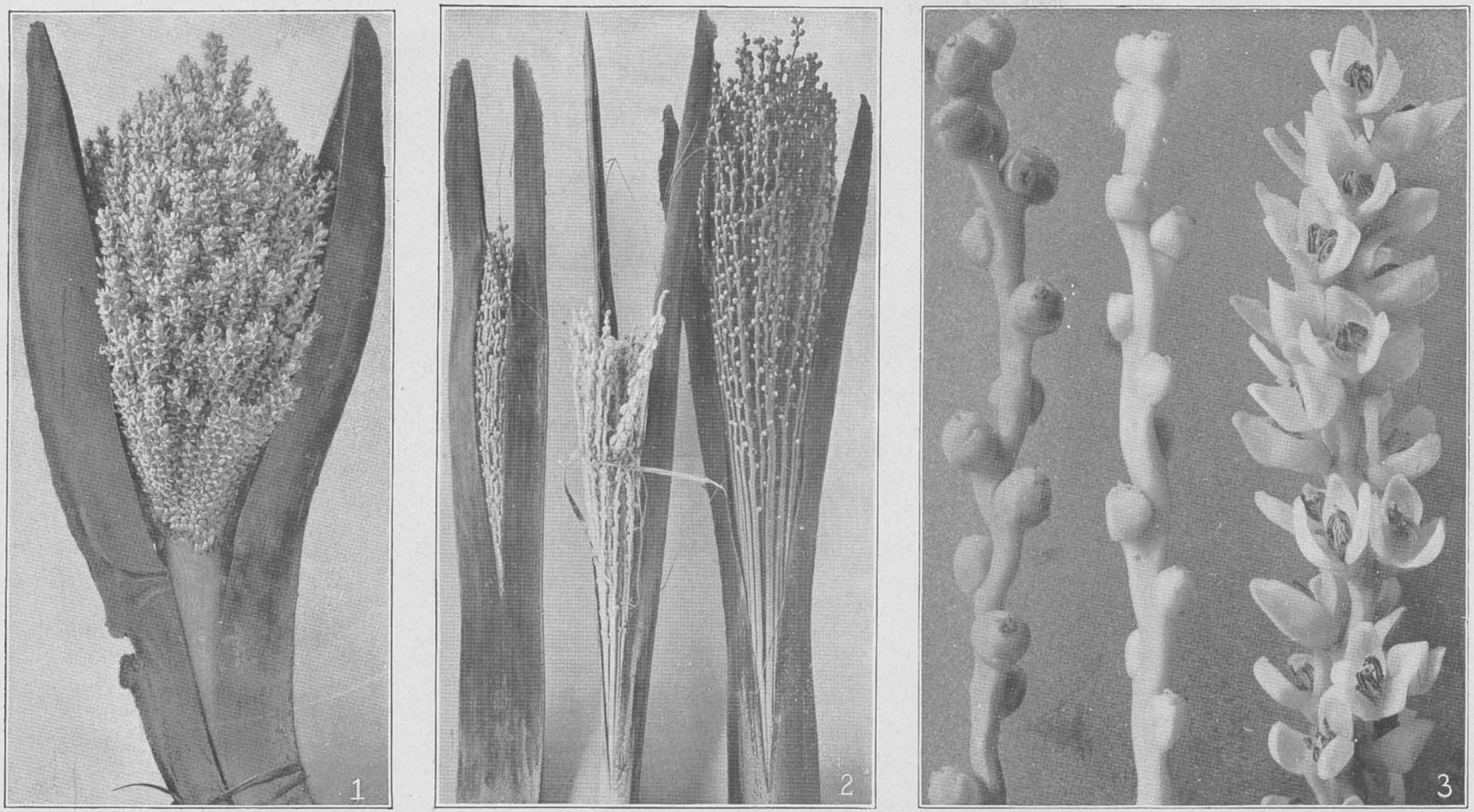
### THE AGE AT WHICH DATE PALMS BEAR.

The age at which palms come into bearing depends much upon the climate and soil; where planted in rich soil, watered abundantly, and where the summer heat is intense and long-continued, the date may begin to fruit when very young. Trees have been known to bear in Arizona within four years after the seed was planted; however, such palm trees are too small to bear more than a very few fruits, and seedling trees are generally considered not to yield paying quantities of fruit until they are at least 6 or 8 years old. When date culture is practiced scientifically, practically no seedlings are grown, but instead orchards are started by planting fairly large offshoots, which soon strike root, and which often bear abundantly four or five years after being transplanted. However, in the large plantations made in Algeria by the French it is not considered advisable to allow the palms grown from offshoots to bear fruit until six years after they are transplanted, and the trees are not in full bearing until ten or eleven years after they are planted. They continue bearing from this age if well cared for until they are a hundred years or more old, a good tree producing an average of from 100 to 200 pounds of fruit a year, although some trees have been known to produce as much as 400 or 600 pounds when grown in rich soil and abundantly irrigated. The tree shown in Pl. LVII, fig. 1, is a demonstration of the capabilities of Arizona as a date-producing country. It is only eight years old from the seed, and yet bears some 400 pounds of dates. Again, the Amreeyah palm, shown in Pl. LXII, fig. 1, grown from an offshoot imported by the Department of Agriculture from Egypt in 1889, yielded last year (1900) over 300 pounds of dates. The little palm shown in Pl. LVII, fig. 2, grows on the grounds of the University of Arizona, at Tucson, where the winters are rather cold; nevertheless, this tree, which had been transplanted only five years when photographed, bore two bunches of fruit weighing altogether some 30 pounds.

## POLLINATION OF THE DATE PALM.

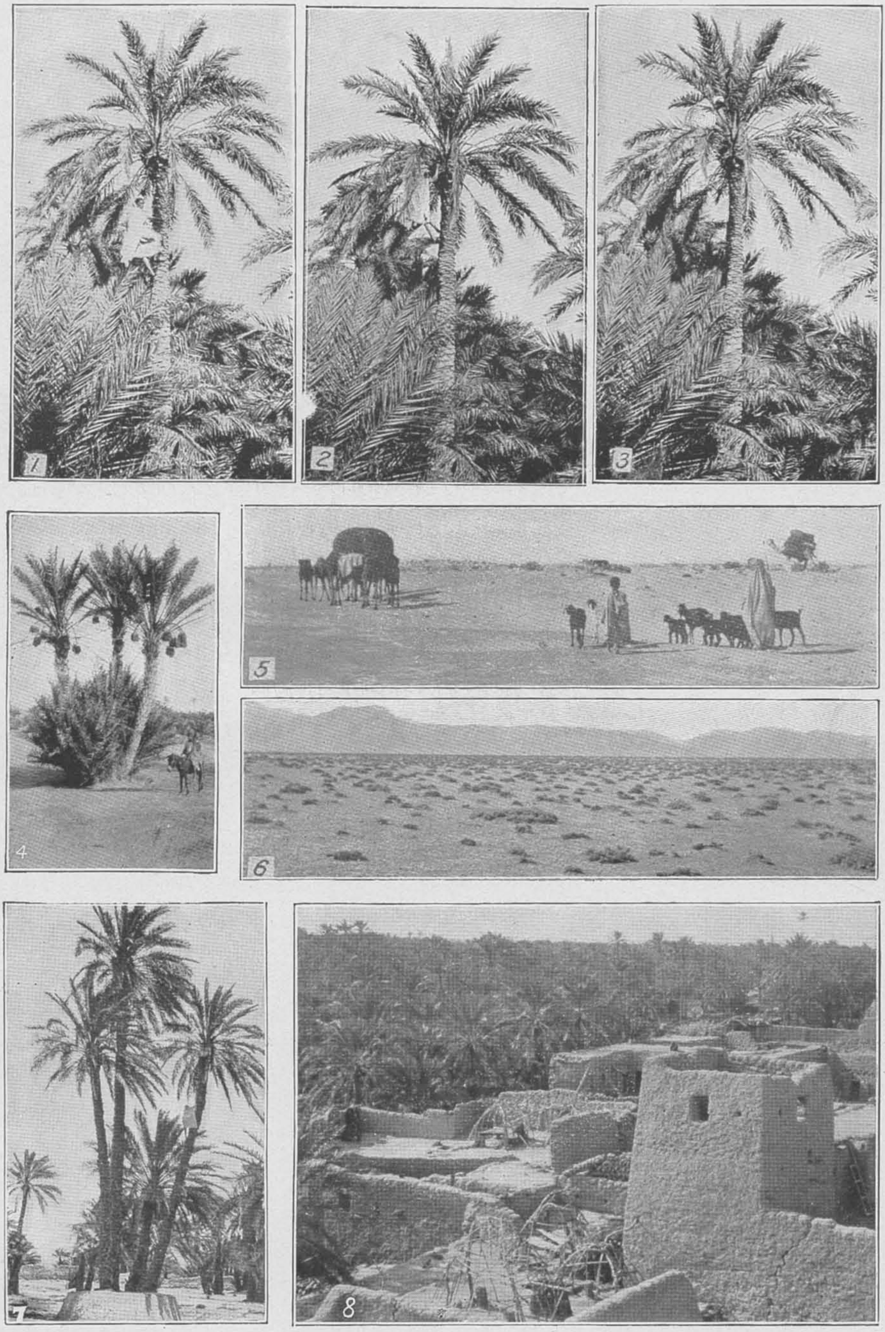
In a wild state the date palm is undoubtedly pollinated by the wind, and about one-half of the trees are male. It is probable that pollination would be incomplete unless the proportion of male trees was something like one-half, for, although enormous quantities of pollen are produced by the male trees, only a very small part ever reaches the female flowers if the pollen is carried by the wind. The artificial pollination of the date palm was doubtless discovered by the ancient Assyrians, and has been practiced probably for three or four thousand years at least. Because of the great economy of pollen, brought about by artificial pollination, one male tree suffices to pollinate a hundred females.

The male flower cluster of the date consists of a stalk bearing a considerable number of short twigs to which the flowers are attached, the whole contained in a sheath at first entirely closed, but which finally ruptures, disclosing the flowers (Pl. LVIII, figs. 1 and 3). The Arabs cut the male flower clusters from the trees shortly before the flowers have fully opened, at a somewhat earlier stage than shown in Pl. LVIII, fig. 1. The separate twigs to which are attached the male flowers (Pl. LVIII, fig. 3, twig to the right) are from 4 to 6 inches long, and bear probably from twenty to fifty male flowers, each containing six anthers full of pollen. One of such twigs suffices to pollinate a whole female flower cluster, and to bring about the development of a bunch of dates. The female flowers, like the male, are borne inside of sheaths, which are at first entirely closed. Finally the sheath is split open by the growth of the flowers within (Pl. LVIII, fig. 2, twig to left), and at this stage pollination is accomplished. The two tips of the cracked-open sheath are separated and the cluster of female flowers pulled out (fig. 60). A twig of male flowers is then inserted into the cluster of female flowers and tied in place with a bit of palm leaf or with a string (Pl. LVIII, fig. 2, twig in middle). This completes the operation of pollination. The fruit cluster soon begins to grow rapidly, and in a few weeks the piece of palm fiber or thread with which the male flowers are held in place is broken by the pressure of the growing fruit cluster. Such a fruit cluster, still confined, but which will shortly break the fiber, is shown in fig. 57.




MALE AND FEMALE FLOWERS AND YOUNG FRUIT OF THE DATE PALM AND ARTIFICIAL POLLINATION.

[Fig. 1.—Flower cluster of the male date palm, just emerged from the split-open sheath; flowers just opened, letting the pollen escape (one-fourth natural size). Fig. 2.—Three flower clusters of female date palm: To left, a flower cluster with sheath split open, in proper stage to be pollinated; in middle, such a flower cluster after artificial pollination, with twig of male flowers tied in place by piece of palm leaf; to right, young fruits a week or ten days after pollination (one-fourth natural size). Fig. 3.—Male and female flowers of date palm magnified: To right, male flowers just shedding pollen; in middle, female flowers ready to be pollinated; to left, young fruits turning green a week or so after pollination (four times natural size).]




POLLINATING DATE PALM AND VIEWS IN THE ALGERIAN SAHARA.

[Figs. 1, 2, and 3.—Arab climbing a date palm in order to pollinate the flowers, Biskra, Algeria (negatives by Charles Trabut). Fig. 4.—Date palms bearing fruit clusters and with offshoots arising at the base (negative by Naudin, Paris). Fig. 5.—Bedouin family traveling in the Desert of Sahara. Fig. 6.—Desert west of Biskra, Algeria, with the Atlas Mountains in the background. Fig. 7.—Palms grown without surface irrigation at Farfar, west of Biskra. Fig. 8.—View from the house tops of Chetma, near Biskra, Algeria.]

In the Algerian Sahara the date begins to flower in April, and sometimes produces flower clusters as late as June 1. The female flower clusters, which may be from five to twenty in number on a single tree, are not all produced at the same time; it is necessary in consequence to pollinate each flower cluster as it appears, and sometimes an interval of several weeks elapses between the appearance of the first and last flower clusters, so the trees must be ascended several times. The Arabs are very expert in doing this work, and seldom overlook a tree, even where the palms are planted without any order; they rarely miss even a single flower cluster. It requires some skill to climb a tall palm tree, as the trunk below is very smooth and it is difficult to pass between the stalks of the lower leaves in order to get at the flowers, since these leafstalks are armed with sharp rigid thorns (Pl. LVII, figs. 1 and 2). The Arabs use no rope or other apparatus to ascend the trees, but climb up with their bare hands and feet (Pl. LIX, figs. 1, 2, and 3).

If date culture should become an important industry in Southwestern United States it is probable that American ingenuity would devise methods of simplifying the work of pollination; for example, it would be easy to devise means of marking the trees, and also the flower clusters, to show which have been pollinated. It might be possible, for example, to tie the male flowers in place with a bright-colored strip of cloth, which would make it easy to see whether all the flower clusters had been pollinated or not. It is possible that Indians will be able to take the place of the Arabs and do this work efficiently. It is absolutely necessary to pollinate all the flowers in order to secure dates of a good quality, although, as mentioned on page 478, the dates do not fall off even if the flowers are not pollinated. It sometimes happens that some of the female flowers appear in spring before any of the male trees have blossomed. To provide a supply of pollen for such flowers, the Arabs make a practice of keeping a few bunches of male flowers from the previous year. These are placed in tight paper bags and hung up in a cool dry place. The pollen is said to keep without deterioration for at least two years. The importance of securing male trees which flower at the right time is noted on page 473.

By an inspection of Pl. LVIII, fig. 3, it will be easy for those who possess seedling date palms to determine the sex of the plant as soon as any flowers are formed. Superfluous male trees can then be destroyed and replaced by female trees before they have reached a large size. In case of gardens where there are a few female date palms and no males available to furnish pollen, it will be necessary to secure pollen from a distance, not a difficult matter, since male flowers can be shipped anywhere without deterioration if protected against loss of pollen.

After irrigation the labor of artificial pollination is the most important required in a date orchard. The irrigating, however, is very nearly such as would be given to any fruit trees, whereas the process of pollination is one that is not required by any other commonly cultivated tree. It should, however, be remembered that for the first ten or fifteen years after date palms are planted the flowers are so near to the ground that artificial pollination is performed very easily. The operation becomes expensive and difficult only when the palms are old and very tall.

### THE GROWTH OF THE YOUNG DATES.

The flowers of the date palm are perfectly white (Pl. LVIII, fig. 3, twig in middle), as are the young fruits for a few days after pollination, but within a week they become green (Pl. LVIII, fig. 3, twig to the left) and begin to grow rapidly. About the end of June, by which time the fruits are of some size, three fruits will have developed from each flower. Then occurs a remarkable phenomenon. If the flowers have been pollinated, two of the three fruits fall, leaving a single date for each flower. If, on the contrary, the flowers have not been pollinated, all three dates remain attached and continue to grow, becoming closely crowded together and somewhat deformed. Such dates never properly mature, are without seeds, and entirely valueless. This peculiar behavior of the date palm enables the cultivator to tell by inspection which bunches have been pollinated and which have escaped attention, and the cutting away of the excess of bunches from too heavily laden trees should be postponed until this time, when it is possible to tell which bunches will mature perfect fruit. As a rule, only one or two clusters should be left on the young date palms which have just begun to bear, and only eight or ten even on old trees. Some varieties do not require much thinning, as they do not produce more bunches than they can nourish properly, whereas other sorts produce twice as many as the tree can support.

### RIPENING OF DATES.

Toward the end of summer the dates, which have been green up to this time, begin to change color, becoming either reddish or yellowish. Later on they frequently become bright red or bright yellow. The attainment of this color is then followed by the slow ripening of the date, which begins at the end of the fruit and slowly advances toward the base. This process of ripening is attended by a complete change of color, the previously yellow dates changing to a clear amber color, while the bright red dates become reddish brown or black as they ripen. Most dates when ripe are more or less translucent, whereas they are perfectly opaque during the red or yellow stage. This final ripening of the date is accompanied by great changes in the texture and composition of the flesh. The unripe dates are usually very astringent and entirely unfit to eat. Even when full grown, and after they have acquired the red or yellow color, they are still unpleasant to the taste. As the dates go through the final stage of ripening, however, the tannin disappears, and in its place the fruit becomes impregnated with sugar, which may amount to as much as 60 per cent of the weight of the dry fully ripe dates. After the dates have become fully matured they begin to dry on the trees, becoming somewhat shrunken (figs. 61 and 62), and within a few weeks are ready to be packed and shipped.

### THE THREE TYPES OF DATES.

Of the three principal types of dates cultivated by the Arabs, only one is exported to Europe and America. This comprises the dates, so familiar to us, called by the Arabs soft dates. They contain sometimes as much as 60 per cent of their weight of sugar, and are, in fact, candied on the tree, being preserved from decay by the enormous amount of sugar they contain. They contain more or less sirupy juice, which is in some varieties so abundant that it must be allowed to drain off before they can be packed.

A second category of dates comprise sorts very like these just mentioned, but containing a much lower percentage of sugar. They do not dry readily, and are usually eaten fresh from the tree. They are to be compared to table grapes rather than to ordinary dates.

The third category embraces what are known to the Arabs as dry dates. These are almost entirely unknown to Americans or Europeans, but are very much esteemed by the Arabs, who consider them to be better for everyday consumption than are the soft dates, which they consider rather a luxury than a staple food. These dry dates are not at all inclined to be soft or sticky when ripe, and are frequently so hard as to be difficult to eat. They are said to drop to the ground as they ripen, and are gathered by simply picking them up from beneath the palms as they fall. If stored in a dry place and protected from weevils they may be kept for years without deteriorating. Dates of this category will probably never come into favor in our markets, since they are entirely unlike any fruit to which we are accustomed.

### VARIETIES OF DATES SUITABLE FOR CULTURE IN THE UNITED STATES.

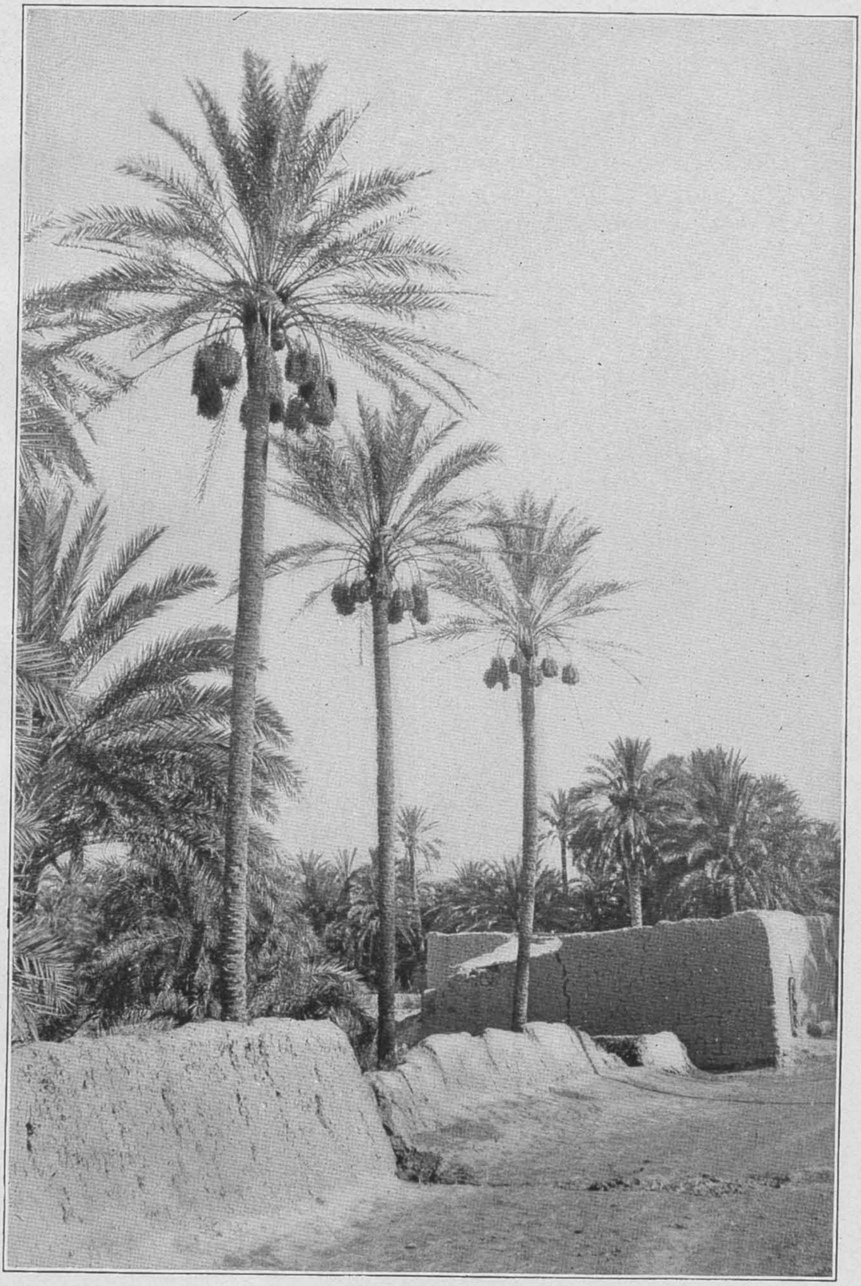
It is a matter of much importance to secure very early varieties of dates for culture in the interior valley region of California where the summer heat is insufficient to ripen late sorts. Many of the dates belonging to the second category mentioned above, which are suitable for eating fresh from the tree, are very early, and consequently likely to succeed in the San Joaquin and Sacramento valleys. The Wolfskill date, grown at Winters, Cal., on Col. Sam Taylor's ranch, produces every year an abundance of delicious fruit of this type (fig. 61 and Pl. LXII, fig. 2). The Amaree (said to be the earliest date in the Sahara) and possibly the Tedmama, are Algerian varieties similar in character. These have been secured and will be tested in California as soon as possible.

There are at least two varieties of the first category, that is, dates that can be dried without difficulty, which are very early and which may succeed toward the northern limits of date culture. Of these, the most important is the Rhars, which is extensively cultivated both by the Arabs and by the French colonists in the Arabian Sahara. It is a date of good quality, but is so full of sirupy juice that it is difficult to cure, and is usually packed closely in skins or boxes for shipment. It is not improbable, however, that a good system of curing and packing would get rid of this sirup and leave the date in a condition like the dates from the Persian Gulf, which are the sorts commonly sold in America. The palm of the Rhars variety grows rapidly and fruits when young. It is said to be easily propagated by offshoots, a large number of which were obtained in 1900, part being sent to California and a part to Arizona. Another early date which can be dried without difficulty is the Tedalla. This variety was brought into notice by M. Yahia ben Kassem. It is a very large date often 3 inches long, and ripens about the same time as the Rhars. It is as yet but little known, even in North Africa, but is a very promising sort. The palm is exceedingly vigorous and bears large crops of fruit.

The medium and late varieties are usually better adapted for drying, and should be grown wherever the climate permits. There are several seedling dates that have originated in the Salt River Valley in Arizona which promise to be valuable. One of the best of these grew from seeds planted by Mrs. S. B. Lount (her No. 6, shown in Pl. LXI, fig. 1); it is small, being rather smaller than the Wolfskill date, but of very good texture, of clear amber color when dried, and of fairly good flavor. The Kales date and the Bennet date (fig. 62) are seedlings of considerable merit, also growing near Phoenix, Ariz. In addition, there are several other seedling varieties of considerable merit which have already fruited in central Arizona, some of which may prove adapted to culture on a large scale.

Two of the varieties introduced from Egypt by the Department of Agriculture in 1890 have been fruiting for some time at Phoenix, Ariz. This year (1900) one of the sorts, the Amreeyeh, bore over 300 pounds (see Pl. LXII, fig. 1), while another, the Seewah, bore over 200 pounds. These dates were packed in half-pound boxes, and Prof. A. J. McClatchie writes that they sold readily for 20 cents a box wholesale and 25 cents retail, and there was a demand in the local market for ten times the amount that could be furnished.

Undoubtedly, the most valuable variety which has yet been sent into



DATE PALMS LOADED WITH RIPE FRUIT, BISKRA, ALGERIA.

[Negative by Naudin, Paris.]

the European and American markets is the Deglet noor, or "date of the light," as the name signifies. This sort is cultivated throughout the western Sahara wherever the season is long enough to enable it to mature, it being one of the later varieties, and requiring much more heat to ripen than does, for example, the Rhars, which it somewhat resembles. It is a medium-sized date (fig. 63), amber-colored, and translucent when ripe, with a soft flesh of the highest flavor. A very important property of these dates is that they do not become sticky, as do most of the soft dates. In consequence of this they may be served as a dessert along with other fruits and eaten without soiling the fingers. It is practically the only variety of date which is regularly so served in the best hotels and at the tables of well-to-do families in France. Some few of these dates reach the United States, where they sell at retail for from 25 to 40 cents for a box containing about three-quarters of a pound. It is hoped that this valuable sort will ripen properly in the Salt River Valley and in other parts of Arizona. In California it will almost certainly succeed in the Colorado Desert, but is likely to fail in other parts of the State. Unfortunately, it is not a very vigorous variety, and does not fruit well unless well fertilized and irrigated. A considerable number of offshoots of the Deglet noor date palm obtained in northern Africa are now growing at Tempe, and within a few years it will be possible to know definitely what regions in the Southwest are adapted to the culture of this superb sort.

There are in all some thousands of named varieties of dates growing in the oases, scattered in the deserts from Morocco to India. Many of these sorts are of superior quality, and should be obtained and tested in the United States as soon as possible. About twenty-five of the best known varieties which grow in the western Sahara are now grown in the date garden at Tempe, Ariz.

## GATHERING, CURING, AND PACKING OF DATES.

Some varieties of dates require practically no curing, being ready to pack and ship as soon as they have ripened. Other varieties, however, require some preparatory treatment. Dates are borne in bunches, which have a single stem with numerous slender twigs to which the fruit is attached (Pl. LVII and Pl. LX). A bunch carries from 10 to 30 pounds. It is very rare that all the dates on a bunch ripen at once, and in the case of choice varieties, those which first ripen are frequently handpicked and shipped at once in order to get the high prices paid for the earliest shipments. It is also claimed that picking the outer dates of the bunch, which usually ripen first, permits the inner fruit to ripen better. Frequently, when most of these dates are ripe and the remainder beginning to ripen, the whole bunch is cut off and hung up in a dry and shady place. It has been found necessary to remove any dates which have begun to spoil before the bunches are hung up, for if such dates are left the whole bunch soon spoils. Usually within a few weeks all of the dates ripen, and the bunch is ready for shipment. The choice varieties of dates are shipped from the Sahara either in bags or more often in long wooden boxes. They are afterwards repacked in smaller boxes, holding from 1 to 10 pounds (fig. 63). The methods above outlined apply to the Deglet noor, which is the variety chiefly exported from Algiers to Europe. Other varieties, such as the Rhars, which are full of sugary juice when ripe, are not so easily handled. The Arabs usually hang up the bunches and allow the juice to drain off into jars. This juice, which they call date honey, is preserved and used, and the fruit, which has become somewhat dry, is then packed in boxes, or more often in skins. Dates of this class are usually packed tightly, and may keep for many years without deteriorating. Somewhat the same style of packing is practiced in the Persian Gulf region, whence come most of the dates received in American markets. There the dates are packed tightly in layers in wooden boxes for export to America and Europe. The dates containing an abundance of sugary juice have the disadvantage of being sticky when unpacked, and are not suitable to serve as a dessert fruit. As before mentioned, the Deglet noor does not have this drawback if properly handled. It has, however, the defect of drying rather rapidly, and from the very fact that it is not tightly packed in boxes it doubtless dries all the quicker. With reasonable care, however, it can be kept for some months in a dry, well-ventilated storeroom, and probably no other dried fruit having a value comparable to the Deglet noor date can be put on the market with so little labor or at so little risk of loss. Practically the only hand labor required is that of arranging the dates in layers in the smaller boxes in which they are sent to the retail trade.

### DATE CULTURE IN MEXICO.

As was mentioned above, the date palm was introduced into Mexico soon after the conquest, probably by means of seeds brought from Spain by the missionaries. Some of the palms, especially in Sonora and Lower California, are very old and have reached a great height. A group of such old date palms is shown on Pl. LIV; these were growing surrounded by orange trees at Hermosillo, which is only 150 miles south of the United States boundary, and has a climate similar to that of the warmer parts of Arizona. There are said, indeed, to be large date palms bearing fruit of good quality in the valley of the Altar River, only 50 miles below the southern boundary of Arizona. Seventy-five years hence the date palms now growing in Arizona will doubtless resemble very closely those of Hermosillo, shown on Pl. LIV.

There is some export of Mexican dates into Arizona and California, and of course still more local commerce in Mexico. According to the statistics published by the Mexican Government, Lower California produced 137,300 kilograms (about 300,000 pounds) in 1897, worth 10,845 Mexican dollars. In 1898 the production amounted only to 32,485 kilograms. Northwestern Mexico, where the climatic conditions much resemble those existing across the American boundary, doubtless produces nine-tenths of the dates grown in Mexico. So far, apparently, no effort has been made to introduce offshoots of the good varieties of dates from the Old World into Mexico, although some of the better seedlings may have been propagated by means of offshoots. In view of the enormous numbers of seedling date palms which occur there, it is probable that some valuable sorts could be discovered by a careful search. These should be found and introduced into the United States.

## DATE CULTURE IN THE UNITED STATES.

### TEXAS, NEW MEXICO, AND NEVADA.

But very few regions in Texas are adapted to the culture of dates. Throughout the eastern half of the State, and in a strip along the Gulf coast, down to the Mexican boundary, the climate is too humid and the summers are too cold to ripen the fruit properly, while in all the northern part of the State, above San Antonio (latitude 30° north), the winters are too cold to permit the date palm to grow out of doors without protection. There is a region lying south and west of San Antonio, between the humid Gulf coast and the Rio Grande, where it is possible that the date may succeed. The summers are hot enough to mature even the medium or late varieties. Fort McIntosh, in Webb County, at 460 feet altitude, has a summer temperature somewhat higher for the months from May to September, inclusive, than at Phoenix, Ariz. The rainfall averages in this region only about 10 inches, and the late summer is usually dry enough to permit dates to ripen; irrigation, of course, would be necessary. Ordinarily the winters are not severe enough to injure the date palm if protected when young, though this part of the State is occassionally exposed to "northers," during which the temperature sometimes falls very low. In February, 1899, for example, it fell to 7° F. or below, all over the region where the date could be grown, and this temperature would doubtless kill or injure even old date palms. Such low temperatures are, however, very exceptional, and the date should be tested in this part of Texas wherever water can be obtained for irrigation.

All of New Mexico is over 2,500 feet in altitude, and nine-tenths of the area is over 4,000 feet; in consequence the winters are almost everywhere too cold to permit the culture of the date palm, and the summer heat is inadequate to ripen any but the very earliest sorts. The winters are too cold to allow dates to be grown in the Pecos and

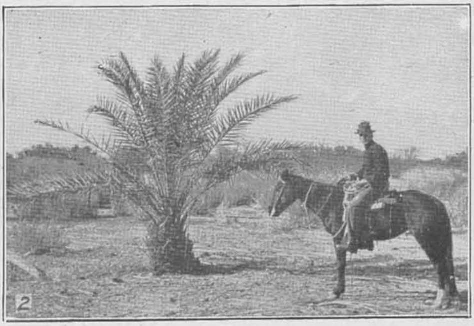
Rio Grande valleys. The most promising locality in which to attempt date culture is at La Luz, at 4,836 feet altitude, in south-central New Mexico, near the Sacramento Mountains. The next most promising region is in the valley of the upper Gila and of the Rio Mimbres, in southwestern New Mexico. This latter region is of considerable extent, but unfortunately the winters are usually so cold that young palms would be injured if not protected; during the cold wave of 1899, the temperature fell below 7° F. at all the stations where records are kept, except at Gage, altitude 4,480 feet, where the record shows a minimum temperature of only 16° F.

It is not impossible that the date may succeed in some protected valleys in southern Nevada. It is almost certain to succeed in the valley of the Colorado River wherever there is any land that can be planted and irrigated. The summers are very hot, and probably even late varieties will succeed wherever it is not too cold in winter. At St. Thomas, at an altitude of 1,600 feet, in the valley of the Virgin River, it is hotter in summer than at Phoenix, Ariz. (altitude 1,100 feet), and even late varieties would ripen. Unfortunately, the winters are occasionally too cold, and in January, 1899, the thermometer fell to 11° F. It is not impossible that there may be a few warm spots in the Pahrump Valley and in Ash Meadows, but no meteorological records are obtainable for these regions, and it is highly probable that the winters are too cold there to permit the culture of the date palm.

### CALIFORNIA.

In California there are two great regions where the climatic conditions permit the culture of the date palm and several smaller areas where it may succeed. The two great regions referred to are: (1) The central valley, comprising the San Joaquin and Sacramento River valleys; (2) the Colorado Desert, in the extreme southeastern part of the State. These two regions differ entirely in climate, and will be found adapted to quite different varieties of dates. The minor regions in California where the date may possibly be grown are the Mohave Desert, or central plateau region; the coast region of southern California; Death Valley, and the Colorado River Valley.

Central valley region.—In the central valley region there is in many places enough rainfall to allow the date palm to grow without irrigation, and, at the same time, no rain falls in late summer or early autumn, when it would prevent the fruit from ripening properly. The winters are sometimes rather cold for the date palm, but if protected when young it succeeds in most parts of this region, and is seldom, if ever, injured when old. The summer heat throughout this entire central valley region is, however, insufficient to ripen any but the earliest sorts of dates, and although it is certain that very palatable dates, suitable for home consumption, can be raised in this



DATE PALMS IN ARIZONA AND CALIFORNIA AND VIEWS IN THE ALGERIAN SAHARA.

[Fig. 1.—The Lount date, Phoenix, Ariz. Fig. 2.—A neglected Egyptian date palm growing without irrigation in Colorado Desert, near Indio, Cal. Fig. 3.—Southern limit of Biskra, Algeria; donkeys loaded with hay in the foreground. Fig. 4.—Date palms grown without surface irrigation at margin of Fougala, Algeria. Fig. 5.—A road in Biskra, Algeria; the date gardens are surrounded by mud walls. Fig. 6.—A well-sweep used for lifting water from shallow wells, Fougala, Algeria.]

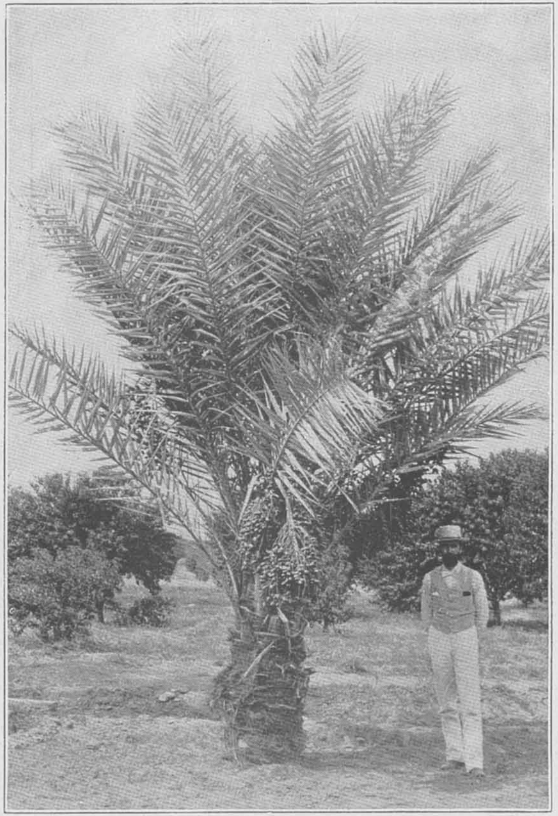


FIG. 1.—AMREEYAH DATE PALM AT EXPERIMENT STATION FARM, PHOENIX, ARIZ.

[Negative by J. W. Toumey.]

FIG. 2.—WOLFSKILL DATE PALM AT WINTERS, CAL.; A LARGER MALE DATE PALM IS SEEN IN THE BACKGROUND.

region, it is not settled as yet that dates suitable for drying and exporting can be produced. It will, however, be possible for settlers all through this region to produce fresh dates for their own tables, and quite probable that these fresh dates can be shipped to the principal Pacific coast cities without spoiling. All parts of the San Joaquin and Sacramento River valleys offer about equal advantages for date culture, except in the region where the two rivers unite. This lies directly east and northeast of San Pablo and Suisan bays, and the cold winds which blow in from the Pacific at San Francisco Bay find their way eastward through this break in the coast range, and thus lower the summer temperature; it is unlikely that any dates can be ripened in this area, which extends from Stockton to Sacramento and across the valley to the foothills.

It is interesting to note that the Wolfskill date (fig. 61 and Pl. LXII, fig. 2), which grows at Winters (latitude 38° 32′ north), about in the latitude of Washington, Lisbon, Athens, and Pekin, is the northernmost date palm in the world which ripens fully its fruit, with the exception of one tree at Nice, France (latitude 43° 45′ north), which is probably not a true date palm, but a hybrid between the date palm and the Canary Island palm. It is, however, probable that in California dates can be grown far to the north of Winters. In fact, the summer climate at Orland, Corning, Tehema, and Vina, in latitude 40°, seems to be as good as at Winters, and to be only slightly less suitable at Red Bluff or even at Redding, latitude 40° 30′, almost under Mount Shasta. Nowhere else in the world are there any such extensive regions north of latitude 35° where dates can be grown successfully. On page 479, under the head "Varieties," some account is given of the sorts most likely to succeed in this part of California.

Colorado Desert.—The best region for the culture of the date palm in California, and probably the best date region in the New World, is without doubt the Colorado Desert, which occupies an area of some thousand or more square miles in the southwestern corner of California. A large part of the surface of this desert is below the level of the sea, and at Salton it is some 266 feet below sea level, while Salton Lake is considerably lower. The summer temperatures in this desert, especially in the parts lying far below the level of the sea, are very high, as high, in fact, as they are in the interior of the Sahara Desert, reaching at Salton a maximum of 120° to 125°, and having for the month of July an average temperature as high as 107° to 109°. The winter temperatures are rarely low enough to injure the date palms; only once during the last ten years is there a record of temperature below 20°, and sometimes, in the lower parts of the desert, the thermometer does not fall below 30° during the whole winter. The air is extremely dry in this desert, and this, together with the intense heat, renders the climate peculiarly adapted to the culture of the best varieties of dates. Unfortunately, there is very little water in this desert, and it will be a very expensive, though probably a very profitable operation, to conduct water from the Colorado River, which furnishes a bountiful supply at all seasons of the year, and which, at Yuma, lies some 400 to 600 feet above the lower portions of the Colorado Desert. There are some flowing artesian wells in the northern part of the desert, especially near Indio, and it may be possible to inaugurate here date culture on a small scale. If adequately supplied with water the lower and hotter parts of the Colorado Desert would be one of the finest date regions in the world, and beyond question the best within the limits of the United States. It must be remembered that its aridity, the extreme heat in summer, and the unusual dryness of the air, all conditions distinctly favoring the production of the best quality of dates, prohibit the culture of many other kinds of fruit trees. Then, too, the lower part of the desert has a very alkaline soil, so that there are without doubt many portions of the Colorado Desert where the growing of dates is the only profitable culture that could be inaugurated.

Plateau region.—This table-land, comprising the Mohave Desert, separating northern from southern California, would be fairly well adapted for date culture were it not for the fact that the winters are commonly too cold. However, in canyons or ravines facing southward, and where there is a good drainage of cold air, the hardier varieties may pass the winter uninjured. From the weather records at Keeler and Barstow it would seem probable that the date might succeed in the vicinity of these towns. If any attempt is made to grow date palms in this part of the State, and for that matter in the colder portions of the interior valley region, attention should be given to the experiments made by the California experiment station at Tulare, where it was found that irrigation in late summer is very disastrous to the date palm, because it forces a late growth, which is injured during the following winter. By selecting hardy varieties, and being careful not to irrigate late in the season, the palms will be able to endure considerable cold in winter. However, all through the plateau region the summer heat is insufficient to ripen any but early sorts, and it is very unlikely that date culture will prove a profitable industry in this part of California.

Coast region of southern California.—Although the winters are never severe enough to injure the date palm, and almost no rain falls during summer and early autumn, it is nevertheless improbable that dates can be grown with profit in this part of California, for the simple reason that the winds which blow off the ocean are cold and humid and prevent the summer heat from being sufficient to ripen dates for 25 miles or more from the coast. It has been found that the date palm does occasionally ripen fruit at San Diego, but the plant is forced entirely out of its normal habits by the extremely low spring and summer temperatures which prevail there, and instead of flowering in April, as it does in Sahara, it often does not bloom until August, in which event the half-grown dates hang on the trees in a green condition all through the winter and ripen during the following summer. The date palm which ripens fruit at Nice, referred to on page 485, may be found adapted to the California coast region. Unfortunately, this tree has not yet produced any vigorous offshoots, but seedlings have been obtained and will be tested in California.

Death Valley region.—In the Death Valley, which is a depression in some places 320 feet below sea level, situated in east-central California, near the boundary of Nevada, the summers are hot enough to ripen even the late varieties of dates, and it is probable that in some protected localities the winters are mild enough to allow the date palm to grow without protection. Here the great difficulty is to find water for irrigation, since the Death Valley is entirely devoid of large streams, and it is still doubtful whether any artesian water can be found there. If an adequate water supply could be found it would be very desirable to make a thorough test of the date palm in this region, since in summer the temperature reaches a point exceeded only by some stations in the Colorado district, and it ought to be possible for late varieties to ripen completely. There is practically no rainfall, and the crop could ripen without danger from late summer or early autumn showers.

Colorado River Valley region.—Early varieties are likely to succeed without artificial irrigation in the flood plain of the Colorado River, where they are abundantly watered and fertilized by the annual overflow. In regions lying a few hundred feet above the river it is probable that even late varieties would mature their fruit if, by any means, water could be obtained with which to irrigate them. This will be explained more in detail in considering the prospects for date culture in Arizona.

### ARIZONA.

As has been explained in the paragraph on the requirements of the date palm as to heat, the earlier varieties will probably succeed in some parts of Arizona lying as high as 5,000 feet above sea level, and medium or late sorts in most parts below the altitude of 2,000 feet, except where there is a marked drainage of cold air from some higher level. This would include the whole of southwestern Arizona, with an arm running up the Gila River, and up the Salt and Verde rivers, and another extending along the Colorado River northward, passing around the tributary which is called the Bill Williams River, and reaching as far north in the Grand Canyon as the Hualapai Indian reservations. This portion of Arizona, lying below the 2,000-foot contour line, forms on the map the shape of a capital L with a very thick horizontal piece. The date palm can probably be grown with success in some regions above the 2,000-foot line, especially in protected valleys which face toward the south. It must not be supposed, however, that any large part of the 20,000 or more square miles included in the area above limited will ever be planted to date palms or to any other fruit trees, since most of this area is without adequate water to carry on agriculture. The irrigable areas along the Gila River and its tributaries, especially the Salt River Valley, and the Upper Gila Valley from Florence westward to the Estrella Mountains, and finally the valley of the lower Gila, especially about Gila Bend, are the localities best adapted to the culture of the date palm. The whole of the valley of the Colorado, so far as it is irrigable, is also adapted to the culture of the date palm, but probably only the earlier varieties will succeed. Of the regions just mentioned, only one is now furnished with a sufficient supply of water to render date culture possible on any large scale. This is the Salt River Valley from Mesa westward to Peoria. Wherever small amounts of water are available in the other valleys it could be utilized for irrigating date palms, which would undoubtedly succeed, and it is probable that in the future, with increased facilities for irrigation, the upper and lower valleys of the Gila will prove especially adapted to this culture.

The valley of the Colorado River will support date palms in many places without irrigation, as is proved by the luxuriant growth of the seedlings planted by Mr. Hall Hanlon, on the California side, a few miles west of Yuma. These dates, however, do not ripen in ordinary seasons, and it is probable that only earlier varieties will succeed on lands subject to overflow by the Colorado River. Not only is the temperature low because of the drainage of cold air into the flood plain of the river, but also because in summer, usually during June or July, the Colorado overflows its banks, and for some weeks the ground is covered with the cold water which flows from the melting snows on the mountains of Colorado. The culture of earlier varieties of dates, however, is exceedingly promising here, and should be carefully tested, since it is probable that thousands of acres of the flood plain of the Colorado will support date palms without irrigation other than that furnished by the annual overflow. On the higher land near the Colorado not subject to overflow, and consequently warmer, it is probable that even late varieties will come to perfect maturity. The weather records kept at Yuma and at Needles would indicate conditions favorable for the culture of all ordinary varieties in case water can be obtained for irrigation.

There is a region in south-central Arizona lying to the south of the Casa Grande ruins where there are said to be thousands of acres covered with a heavy growth of mesquite timber and where there is underground water at the depth of from 20 to 30 feet. It is not impossible that, if date palms were irrigated in this region when young, they might be able to grow without irrigation after the roots reached moisture. At any rate, both here and elsewhere, where a heavy growth of mesquite occurs, and where there are indications of underground water near the surface, it would be desirable to make trial plantations of the date palm.

Salt River Valley.—This fertile region, which is one of the largest of the irrigated valleys in the Southwest, is situated in central Arizona (latitude 33° 25′). Its principal towns are Phoenix, Tempe, and Mesa. As has already been mentioned, the date palms planted by the earlier settlers have been strikingly successful; in fact, it is no exaggeration to say that there are more bearing date palms, producing fruit of good quality, in the Salt River Valley than in all the rest of the United States. Prof. James W. Toumey, while connected with the University of Arizona, investigated the whole subject of the culture of the date palm in the United States, and brought out very clearly, in a bulletin[1] published in June, 1898, the fact that in these regions only had the plants imported by the Department of Agriculture in 1889 and 1890 grown rapidly and produced good fruit abundantly. This bulletin was the most important study of the date palm ever published in America, and it did much to attract attention to the possibility of establishing date culture as a profitable industry in the Southwest.

Although there are many regions in California, and some in Arizona, where the summer temperatures are higher than they are in the Salt River Valley, there is no considerable area of land under irrigation where the climate is so favorable to the date palm, and unless the Colorado Desert be some day irrigated, either by artesian wells or by conducting water from the Colorado River, it is not unlikely that the Salt River Valley will retain its preeminence in date culture. It may, in fact, be stated that date culture is no longer an experiment in the Salt River Valley. It is, however, not yet certain that the Deglet noor variety, which is now the one most desired in the markets, will come to full maturity here. It is to be hoped that it will, and the outlook is certainly promising. If this variety does ripen properly, there can be but little question that it will be profitable to plant it on the very best lands in the valley and to irrigate it abundantly. The question as to whether the Deglet noor can mature its fruits in central Arizona will be settled within a very few years by the experiments now in progress at Tempe, in this valley (fig. 59). If it should be found that this variety does not succeed, it will still be possible to grow the other varieties, certainly as good as the Persian dates, which now

[1] "The date palm," by J. W. Toumey, University of Arizona, Arizona Agricultural Experiment Station Bulletin No. 29, Tucson, Ariz., June, 1898, pp. 50, figs. 13.

constitute 99 per cent of the total supply imported into America. In this event, however, the price received per pound would be much less than what is paid for the Deglet noor dates, and it is probable that it would not be profitable to plant the date palms on land that is well adapted to other fruit trees. There are, however, lands which are too alkaline to be well adapted to other crops where the date palm would thrive very well. Some of these lands have water rising to within a few feet of the surface, and it is probable that the date palm would grow in such situations without any irrigation at all, though it would probably grow better and yield more fruit if occasionally irrigated with pure water, such as is supplied by the irrigating canals.

## CONCLUSION.

It has been shown that there is good ground for the hope that enough dates to supply our markets may be produced within our boundaries, thus retaining in this country nearly half a million dollars now paid annually for foreign dates. It is even possible that a still larger trade may be built up by producing the choicer varieties suitable for serving as table fruit, such as the Deglet noor, now so rare on our markets and so costly as to preclude its being sold in any large quantities.

The date palm has been shown to be adapted to special climatic and soil conditions, occurring only in a few areas of limited extent in the Southwest. It requires a long, extremely hot and dry summer in order to mature its fruits properly, yet the roots demand a constant supply of water. It is unable to endure severe cold in winter, although more hardy than the orange tree. It is preeminently suited for culture in irrigated areas in desert regions, and fortunately is able to endure without injury large quantities of alkali in the soil and in the water used for irrigating, conditions often occurring in desert regions, and which prevent the growth of most cultivated plants. There are many places in Arizona and California where the culture of the date can be undertaken with good hope of success. Marketable dates of good quality have already been produced in considerable quantities in the Salt River Valley, Arizona, and excellent fresh dates ripen every year at Winters, in northern California.

The Department of Agriculture and the University of Arizona have undertaken in cooperation the establishment and maintenance of a special date garden at Tempe, in the Salt River Valley, Arizona, and in 1899–1900 about 420 young palms, comprising about 27 of the best-known varieties, including the famous Deglet noor, were imported by the Department from the best date regions of the western Sahara and sent to this garden, where they are now growing. Some three dozen plants of the Rhars, one of the best early dates for drying, were distributed at the same time in California in cooperation with the University of California.

# PRACTICAL IRRIGATION.

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## INTRODUCTION.

When a farmer enters a new country where irrigation is necessary he must determine (1) how he may best deliver water to his land, and (2) what crops are adapted to the soil and for local uses. Everything with him is tentative. Unless he is fortified by an income outside of that obtained from his farm, the first few years he has a struggle for existence. That the pioneer is often overcome in this unequal fight is evidenced by many deserted homes and unfinished irrigation works. Owing to his inexperience in irrigation, he may lose his crops by not using the proper volume of water or by using it at the wrong time. One failure often means the abandonment of everything and a retreat to a region where conditions seem more favorable. In a new country where the rainfall is ample for the growth of crops serious obstacles must be overcome before returns are received for the labor expended. If, in addition to these difficulties, water must be brought to the land for irrigation and domestic purposes, the problems become much more complicated, and correspondingly greater credit is due when success rewards the attempt.

To the Eastern farmer, whose cultivated lands are rolling and broken, the problem of spreading water over the surface of the ground from ditches has some serious phases. Often the stream passing his farm is bordered by steep bluffs, and its fall seldom exceeds 3 or 4 feet per mile. In his judgment the cost of raising water from such a source in sufficient quantities for irrigation would not be justified by the slight increase in yields or the saving of an occasional crop.

The Western irrigator would arrive at the same conclusion if he had to deal with similar conditions. His agricultural land is nearly always smooth, and usually has a gentle slope with and toward some natural drainage channel, and would bear no crops without irrigation. The stream from which he proposes to draw his supply of water has a large fall, so that a ditch taken from it with a moderate grade can recede rapidly, and hence cover a large area in a short distance. A combination of these features makes it possible for individuals to construct irrigation works on the smaller streams. This paper will deal with the kind of ditch a settler of limited means could build in a region of abundant water supply.

### SMALL DITCHES WITH VARYING GRADES AND CROSS-SECTIONAL AREAS.

The pioneer irrigator knew but little regarding the measurement of water, the carrying capacity of ditches, or the volume demanded by various crops. The experience of the first few years often convinced him that his ditch was too small, and he was compelled to enlarge it to provide an ample supply of water. The volume one man could handle he called an "irrigating head." This was his first unit of measurement, and his ditch carried one, two, or three irrigating heads, according to his estimate. Crude measurements were afterwards adopted to aid his judgment. He found it comparatively easy to measure the cross-sectional area of a stream. His first gaugings were made in this manner, usually disregarding the velocity of the current. Experience in building ditches taught him in a few years how to adjust the size and grade of his ditch so as to furnish an adequate supply of water for the area to be irrigated. Some of the following considerations have been suggested by his experience.

Many things affect the ease with which ditches can be built and water distributed from them. The length of ditch necessary to cover any piece of land depends on its fall compared with that of the stream and upon the elevation of the land to be irrigated. The smaller the grade of the ditch and the greater the fall of the stream, other things being equal, the shorter the ditch. However, the grade of the ditch should not be too light; otherwise its section must be greatly increased to deliver the desired volume of water. The grade must not be excessive or the increased velocity of the current will result in the erosion of the ditch banks. Therefore the range of grade which a ditch may have is limited, and its length largely depends on the fall of the stream.

On the quality of the soil through which the ditch must be constructed depend the permanency of its channel, the rate of velocity at which water can safely be carried, the cost of first construction, and the economic value of the ditch as a water carrier. As cheapness is a requisite for the construction of the class of ditches to be dealt with in this paper, rockwork or expensive flumes and other structures will not be considered.

In order to more clearly show the difficulties to be met and overcome, a practical case will be considered. Assume that it is desired to irrigate an area of 40 acres lying near a creek furnishing a sufficient supply of water; assume, also, that the creek has a fall of 20 feet per mile, and that the highest point of the land to be irrigated is 15 feet above the bottom of the creek at the nearest point. It will be seen that a point on the creek three-quarters of a mile above is on the same level with the highest point of the 40 acres. It is evident that the headgate of the ditch must be above this point if we expect the water of the creek to flow to the farm, unless a dam be built in the creek to raise the water higher than its usual level.

It may be interesting, as well as profitable, to compare a few of the possible lines upon which the ditch might be built. That water tends to seek its own level is a principle that needs no demonstration, and it might be supposed that the least grade would cause the water to flow through the ditch. While this is true, it does not entirely answer the purpose, for the ditch must not only be one in which water will flow, but it must allow the water to run fast enough to deliver at the place where used a definite volume in a given time.

The accompanying diagram (fig. 64) shows the relation between the grades of the ditches and the fall of the stream. The line *03* represents a level line through the bottom of the creek at the farm and running upstream from the farm. *A15* is a level line through the highest point of the farm. The line *0E* is the grade of the stream, 20 feet per mile. The numbers *0*, *1*, *2*, and *3* at the bottom of the diagram indicate miles upstream from the farm, and the numbers *15*, *20*, *30*, *40*, and *60*, at the right, show elevation, in feet, above the bottom of the creek at the farm. *AB*, *AC*, *AD*, and *AE* are the lines of ditches built on grades of one-half, 5, 10, and 15 feet per mile, respectively. The distances from the point *0* to the perpendiculars dropped from the points *B*, *C*, *D*, and *E*, measure the approximate lengths of the ditches built on the corresponding grades. As above stated, the grade of the stream is 20 feet per mile. If the grade of the ditch is 15 feet per mile the two lines would approach each other at the rate of 5 feet per mile, and would come together at the point *E*, 3 miles above the farm. Following the line *E3* to the base of the diagram, it is seen that the length of the ditch is 3 miles. If the minimum

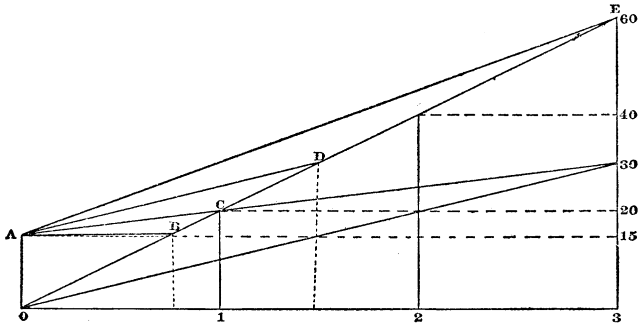


FIG. 64.—Diagram showing lengths of ditches with different grades.

grade is taken at one-half foot per mile, the length is about three-quarters of a mile. The corresponding lengths of the ditches having grades of 5 and 10 feet per mile are 1 and 1½ miles, respectively.

To illustrate how the length of the ditch depends upon the fall of the stream, let the line *0–30* represent the grade line of a stream having a fall of 10 feet per mile. *A C* produced to *30* shows that a ditch having a fall of 5 feet per mile is 3 miles long.

The following table gives dimensions of a number of small ditches, with the corresponding velocities and discharges for different grades; also the volume of material, in cubic yards, to be removed per mile:

*Velocities and discharges of ditches with different grades.*

| Dimensions of ditch. | | | | Grade of ditch, 6 inches per mile. | | Grade of ditch, 1 foot per mile. | | Grade of ditch, 2 feet per mile. | | Grade of ditch, 3 feet per mile. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Top width. | Bottom width. | Depth. | Area of cross section. | Velocity. | Discharge. | Velocity. | Discharge. | Velocity. | Discharge. | Velocity. | Discharge. |
| *Feet.* | *Feet.* | *Feet.* | *Sq. ft.* | *Feet per sec.* | *Cu. ft. per sec.* | *Feet per sec.* | *Cu. ft. per sec.* | *Feet per sec.* | *Cu. ft. per sec.* | *Feet per sec.* | *Cu. ft. per sec.* |
| 1.5 | 1 | 0.5 | 0.625 | 0.18 | 0.10 | 0.34 | 0.21 | 0.50 | 0.31 | 0.61 | 0.38 |
| 3.0 | 2 | 1.0 | 2.5 | .35 | .86 | .48 | 1.21 | .72 | 1.81 | .87 | 2.27 |
| 4.5 | 3 | 1.5 | 5.625 | .46 | 2.56 | .67 | 3.77 | 1.00 | 5.60 | 1.20 | 6.72 |
| 6.0 | 4 | 2.0 | 10 | .50 | 5.00 | .85 | 8.50 | 1.24 | 12.40 | 1.49 | 14.90 |
| 7.25 | 5 | 2.25 | 13.78 | .67 | 9.23 | .96 | 13.23 | 1.38 | 19.02 | 1.69 | 23.29 |
| 8.5 | 6 | 2.50 | 18.12 | .74 | 13.40 | 1.06 | 19.20 | 1.52 | 27.54 | 1.87 | 33.88 |
| 9.75 | 7 | 2.75 | 23.03 | .81 | 18.65 | 1.15 | 26.48 | 1.66 | 38.23 | 2.04 | 46.98 |
| 11.0 | 8 | 3.0 | 28.50 | .88 | 25.08 | 1.26 | 35.91 | 1.78 | 50.73 | 2.18 | 62.13 |
| 12.25 | 9 | 3.25 | 34.53 | .93 | 32.13 | 1.34 | 46.27 | 1.93 | 66.64 | 2.36 | 81.49 |
| 13.50 | 10 | 3.5 | 41.12 | 1.00 | 41.12 | 1.44 | 59.21 | 2.04 | 83.88 | 2.50 | 102.78 |

| Dimensions of ditch. | | | | Grade of ditch, 4 feet per mile. | | Grade of ditch, 5 feet per mile. | | Grade of ditch, 6 feet per mile. | | Grade of ditch, 7 feet per mile. | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Top width. | Bottom width. | Depth. | Area of cross section. | Velocity. | Discharge. | Velocity. | Discharge. | Velocity. | Discharge. | Velocity. | Discharge. |
| *Feet.* | *Feet.* | *Feet.* | *Sq. ft.* | *Feet per sec.* | *Cu. ft. per sec.* | *Feet per sec.* | *Cu. ft. per sec.* | *Feet per sec.* | *Cu. ft. per sec.* | *Feet per sec.* | *Cu. ft. per sec.* |
| 1.5 | 1 | 0.5 | 0.625 | 0.71 | 0.44 | 0.81 | 0.51 | 0.91 | 0.57 | 0.96 | 0.60 |
| 3.0 | 2 | 1.0 | 2.5 | 1.01 | 2.53 | 1.16 | 2.89 | 1.29 | 3.23 | 1.37 | 3.42 |
| 4.5 | 3 | 1.5 | 5.625 | 1.39 | 7.84 | 1.59 | 8.97 | 1.78 | 9.97 | 1.88 | 10.56 |
| 6.0 | 4 | 2.0 | 10 | 1.74 | 17.40 | 1.99 | 19.90 | 2.21 | 22.10 | 2.34 | 23.40 |
| 7.25 | 5 | 2.25 | 13.78 | 1.96 | 27.00 | 2.18 | 30.04 | 2.43 | 33.48 | 2.63 | 36.24 |
| 8.5 | 6 | 2.50 | 18.12 | 2.20 | 39.86 | 5.45 | 44.39 | 2.68 | 48.56 | 2.90 | 52.54 |
| 9.75 | 7 | 2.75 | 23.03 | 2.36 | 54.34 | 2.63 | 60.56 | 2.88 | 63.20 | 3.12 | 71.85 |
| 11.0 | 8 | 3.0 | 28.50 | 2.56 | 72.95 | 2.86 | 81.50 | 3.13 | 89.20 | 3.38 | 96.32 |
| 12.25 | 9 | 3.25 | 34.53 | 2.73 | 94.26 | 3.05 | 105.31 | 3.34 | 115.33 | ........ | ........ |
| 13.50 | 10 | 3.5 | 41.12 | 2.86 | 117.18 | 3.22 | 132.40 | ........ | ........ | ........ | ........ |

*Velocities and discharges of ditches with different grades*—Continued.

| Dimensions of ditch. | | | | Grade of ditch, 8 feet per mile. | | Grade of ditch, 9 feet per mile. | | Grade of ditch, 10 feet per mile. | | Volume of material to be removed per mile.[1] |
|---|---|---|---|---|---|---|---|---|---|---|
| Top width. | Bottom width. | Depth. | Area of cross section. | Velocity. | Discharge. | Velocity. | Discharge. | Velocity. | Discharge. | |
| *Feet.* | *Feet.* | *Feet.* | *Sq. ft.* | *Feet per sec.* | *Cu. ft. per sec.* | *Feet per sec.* | *Cu. ft. per sec.* | *Feet per sec.* | *Cu. ft. per sec.* | *Cu. yds.* |
| 1.5 | 1 | 0.5 | 0.625 | 1.04 | 0.65 | 1.09 | 0.68 | 1.17 | 1.04 | 122 |
| 3.0 | 2 | 1.0 | 2.5 | 1.48 | 3.70 | 1.55 | 3.88 | 1.66 | 4.26 | 489 |
| 4.5 | 3 | 1.5 | 5.625 | 2.03 | 11.42 | 2.13 | 11.99 | 2.28 | 12.85 | 1,100 |
| 6.0 | 4 | 2.0 | 10 | 2.53 | 25.30 | 2.66 | 26.60 | 2.85 | 28.50 | 1,956 |
| 7.25 | 5 | 2.25 | 13.78 | 2.81 | 38.72 | 2.98 | 41.05 | 3.13 | 43.13 | 2,695 |
| 8.5 | 6 | 2.50 | 18.12 | 3.10 | 56.16 | 3.28 | 59.42 | 3.46 | 62.69 | 3,544 |
| 9.75 | 7 | 2.75 | 23.03 | 3.33 | 76.68 | ........ | ........ | ........ | ........ | 4,504 |
| 11.0 | 8 | 3.0 | 28.50 | ........ | ........ | ........ | ........ | ........ | ........ | 5,573 |
| 12.25 | 9 | 3.25 | 34.53 | ........ | ........ | ........ | ........ | ........ | ........ | 6,752 |
| 13.50 | 10 | 3.5 | 41.12 | ........ | ........ | ........ | ........ | ........ | ........ | 8,041 |

[1] In computing the volume of material in cubic yards per mile to be removed in the construction of each ditch, it is assumed that the ditches follow the surface of the ground, thus maintaining a constant depth.

The ditches whose dimensions are given in the above table are of such sizes as would ordinarily be built. They vary from 1 foot to 10 feet in width on the bottom and from 6 inches to 3½ feet in depth. It will be seen that the velocity of the water depends largely upon the cross-sectional areas of the ditches. The velocity in the smallest ditch, with a grade of 6 inches per mile, is 0.18 of a foot per second, while the velocity in the largest ditch given in the table for the same grade is 1 foot per second, or about five and one-half times as great. By comparing the velocities given in any one column of the table it is seen that the water in the largest ditch has four to five times the velocity that it has in the smallest one. Knowing the quantity of water which the ditch must carry, and the permissible grade, the size can be determined by reference to the table.

For instance, 2½ cubic feet of water per second is delivered by a ditch 3 feet wide on the top, 2 feet wide on the bottom, and 1 foot deep, with a grade of 4 feet per mile. The table shows that practically the same volume is carried by a ditch 4½ feet wide on top, 3 feet on the bottom, and 1½ feet deep, with a grade of 6 inches per mile. It may be instructive as well as interesting to compare these two ditches to determine which is the more economical to construct and to use.

If built to convey water to the farm located as before described the larger ditch would be about three-fourths of a mile long and would require the removal of 825 cubic yards of earth. The smaller ditch would be about 1 mile long and 489 cubic yards of earth would be removed in its construction, a saving in the volume of earth of 41 per cent. The losses from seepage and evaporation in the two ditches would be in proportion to the surfaces exposed to the soil and to the air, and on this basis the loss in the larger ditch would be 12.5 per cent greater than that in the smaller. This comparison shows that the cost of construction of the smaller ditch is less, and that it is a more economical water carrier than the larger one.

In watering most crops the experienced irrigator knows that it is more economical to use a large head of water than a small one. A person can irrigate a given area in less than one-half the time with 2 cubic feet per second that would be required with 1 cubic foot per second, and it might be utterly impossible to irrigate the land with one-half a cubic foot per second, for the reason that the stream would likely be absorbed by the ground and sink into the subsoil instead of flowing over the surface.

In the irrigation of most crops a man can handle 2 or 2½ cubic feet of water per second with little difficulty. Assuming that 2½ cubic feet of water per second is the largest volume that will be required at any one time, the problem is to construct a ditch that will deliver this amount to the land. The size of the ditch and the grade upon which it is to be built are questions which should be decided approximately before the trial line is run.

### METHODS OF RUNNING GRADE LINES FOR SMALL DITCHES.

The grades for many of the early ditches were established by plowing a furrow or digging a trench from the creek to the land to be irrigated and permitting the water to follow as the channel was opened. If the water flowed too rapidly the furrow was turned toward higher ground, and in case the water failed to follow the trench lower ground was sought. After running the preliminary furrow the final adjustment in the grade was made by plowing a second one, which eliminated the depressions and deviations in the first.

The degree of accuracy which may be attained in grade lines run in this manner varies with the care taken in running the first and second furrows and in estimating the velocity of water flowing in them. If the banks of the ditch are high enough to prevent the water from overflowing them, time will usually even up the little inequalities in grade. Especially will this be true of those ditches that carry an appreciable quantity of silt, which is deposited wherever the current is slow. In this way depressions are filled up and the ditch is made even and uniform. This "leveling up" process is not confined to the ditch laid out any particular way, but is constantly going on in all waterways where inequalities of grade exist. One advantage conferred by this method is that no mistakes are made in the location, that is, there are no stretches in the ditch where no grade is allowed, nor does the grade run in the wrong direction. Wherever water flows in a small trench or furrow it will flow more readily in the completed ditch.

### TRIANGLE WITH PLUMB BOB.

One of the most common forms of leveling device is the triangle or "A." It has probably been used to run the grades for a greater number of ditches than any other except the engineer's level. The ease with which it can be constructed and the simplicity of its adjustment and use are the points that have appealed strongly to the pioneer ditch builder. The usual form is that of a triangle whose base and longest side is from 10 to 16½ feet in length. The different lengths which may conveniently be used are given in the table following:

*Number of times triangles of different lengths are used in 1 mile and the amounts which should be allowed for various grades.*

| Length of base of triangle. | Number of times triangle must be applied in a mile. | Amount to be allowed in the length of the triangle for different grades. | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 4 feet per mile. | 5 feet per mile. | 6 feet per mile. | 7 feet per mile. | 8 feet per mile. | 9 feet per mile. | 10 feet per mile. |
| *Feet.* | | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* | *Inch.* |
| 10 | 528 | 1/16 | 1/8 | 1/8 | 3/16 | 3/16 | 3/16 | 1/4 |
| 11 | 480 | 1/8 | 1/8 | 1/8 | 3/16 | 3/16 | 1/4 | 1/4 |
| 12 | 440 | 1/8 | 1/8 | 3/16 | 3/16 | 3/16 | 1/4 | 1/4 |
| 15 | 352 | 1/8 | 3/16 | 3/16 | 1/4 | 1/4 | 5/16 | 5/16 |
| 16 | 330 | 1/8 | 3/16 | 3/16 | 1/4 | 5/16 | 5/16 | 3/8 |
| 16½ | 320 | 1/8 | 3/16 | 1/4 | 1/4 | 5/16 | 5/16 | 3/8 |

The headings "4 feet," "5 feet," etc., over the last seven columns of the above table are the number of feet of fall in the ditches per mile of length; the fractions in these columns give in inches the fall

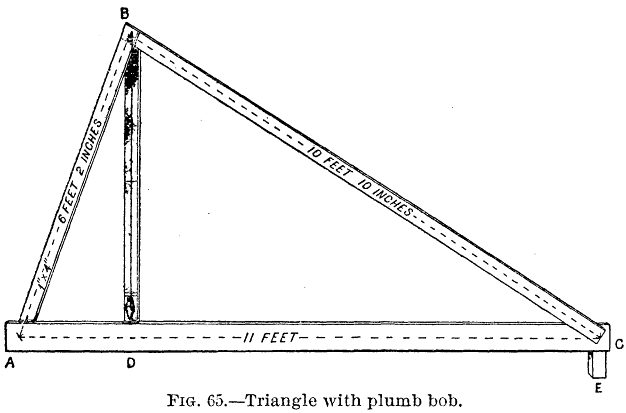



FIG. 65.—Triangle with plumb bob.

which must be allowed in the length of the triangle. These are correct to the nearest one-sixteenth of an inch, which is as close as the instrument can be read. The table shows that if the triangle be 12 feet long and a fall of three-sixteenths of an inch be allowed, the grade of the ditch will vary between 5.5 and 8.5 feet per mile.

Fig. 65 shows a triangle with a base of 11 feet. Its construction requires a 6-inch board, $AC$, 11 feet long, for the base; for the other long side, $BC$, a 4-inch board 11 feet long, and for the short side, $AB$, a 4-inch board 6½ feet long. The 4-inch board, $BD$, along which the plumb line hangs, is 5 feet and 3 inches long. Two or three wide staples should be driven into this board over the plumb line to limit its swing. The plumb line is of such length that the point of the plumb bob just clears the upper edge of the base $AC$. The plumb bob for this device should have a long, slender point, so that its position can be more easily seen. A mark may be made on $BD$ just above the plumb bob to indicate the center of its swing. The line is then read instead of the point of the plumb bob.

The adjustment of the triangle consists in locating and marking the place where the point of the bob or line comes when the base is level. This is done in the following manner: Drive two stakes in the ground, making the distance between them equal to the length of the base of the triangle. The stakes should be driven so their tops will be as nearly level as can be estimated. Place the triangle with the ends of its base resting on the stakes; hold the triangle in a vertical plane and notice if the plumb swings clear of the staples; if it does not, drive the higher stake until it does. The plumb bob is allowed to settle, and a mark is made on the base directly under its point or back of the line on $BD$. The triangle is then reversed upon the stakes and another mark is made on the base or on the upright $BD$. A permanent line is then drawn across the top of the base midway between the two marks already made or between those on $BD$. When the triangle is held in such a position that the point of the plumb bob or the line comes to the last marks made, the base of the triangle is level. A leg shown at $E$, 6 inches long, may be fastened to the forward end of the triangle.

To use the instrument for the location of a ditch line, begin at the lower end of the ditch and proceed as follows: Drive a stake at the starting point, leaving its top 6 inches above the surface of the ground. Place the end $A$ of the triangle on this stake and put $E$ on the ground, along the line of the proposed ditch, and move to higher or lower ground as necessary in order to bring the point of the plumb bob or the line to the mark that serves to indicate when the base is level. Two points on the same level line are thus fixed. It is desired instead to find a point near $E$ higher than the surface of the ground at $A$ by an amount equal to the grade of the ditch in that distance. Shortening the leg $E$ by this amount and moving it to higher ground, keeping the base $AC$ level, the desired point is found. This point is marked by driving a stake in the ground, the top of which is 6 inches above the surface. The proper amount to be cut from the leg $E$ may be determined in this manner: Divide 5,280, the number of feet in a mile, by 11, the length of the base $AC$ of the triangle. The quotient

480 is the number of times the triangle must be applied to the ground in laying out a mile of ditch. Divide the number of inches in the fall of the ditch per mile by 480 and the result will be the amount in fractional parts of an inch by which the leg *E* must be shortened. In a ditch having a fall of 5 feet, or 60 inches, per mile, this is 60 divided by 480, or one-eighth of an inch.

The following method of running grade lines with this device is probably more commonly employed: The leg *E* is dispensed with, and after the point locating the center of the swing of the plumb bob has been located, a piece of wood of such thickness as to allow for the grade in the length of the base is tacked under one of the ends, as at *C*. The work of laying out the line can begin either at the headgate or at the farm. If a suitable location for the headgate is found, it may be desirable to commence there. In this case a stake, having its top 10 or 12 inches above the surface of the ground, is driven at the point selected for the headgate and the end *A* of the triangle is placed upon it. The end *C* is turned in the direction the ditch is to be run, and when the plumb bob comes to rest at the mark indicating that the base is level, a stake is driven so that its top is even with the lower face of the piece of wood fastened under *C*. The tops of the stakes will then have the proper grade, and the triangle can be moved forward with the end *A* on the stake just located and another stake driven as before. This operation is repeated until the entire line is run. The line so located need not follow the contour of the country, but can be made fairly direct. Knowing that the tops of the stakes are on grade, the cut at any place can easily be found. If the top of the first stake is 15 inches above the grade line at the bottom of the ditch, to locate the bottom at any other station it is only necessary to measure down 15 inches from the top of the stake there.

The plumb bob is placed near the rear of the frame, because its position can be more easily seen by a person holding that end upon a stake, and the motion communicated to it by the movement of the end *C* is less.

#### TRIANGLE WITH CARPENTER'S LEVEL.

The triangle is frequently used in connection with the carpenter's level, as shown in fig. 66. This device can be used in windy weather, when it would be almost impossible to run a line with a plumb bob. The frame may be made of two 3-inch boards, *AB* and *AC*, about 8 feet long, and a 2-inch by 4-inch piece, *DE*, about 6 feet long. The two pieces, *AB* and *AC*, are crossed at *A* and fastened with one nail; make the length of *AB* exactly equal to *AC*, say 8 feet, and make marks at *B* and *C* on the center line of the pieces. *BC* is a straightedge about 12 feet long, used temporarily in the construction of the frame. Mark upon its upper edge two points 11 feet apart. Bring the marks at *B* and *C* to the points on the straightedge, which is temporarily fastened with nails in this position. *AD* is now laid off equal to *AE*, say about 4 feet, and the two points *D* and *E* marked. The 2 by 4 piece, *DE*, is now laid across the frame, placing its upper edge on the points *D* and *E*. It is to be fitted and permanently fastened in this position. The 3-inch boards, *BE* and *DC*, are next put in place and nailed there. They hold the ends of the legs securely in position. The amount of fall in 11 feet is then calculated or taken from the table on page 497. It is laid off and marked on *AB*, measuring from the upper edge of *BC*. The piece *BC* is now loosened at *B* and the upper edge brought to this mark. The legs of the triangle are cut along the straightedge of *BC*. The leg *AB* should be marked in some way to indicate that it is to be used on the upstream end of the triangle.

This method of constructing the leveling device assumes that the carpenter's level is in adjustment. If it needs adjusting, remove the level from the frame and proceed as follows: Drive two stakes, *A* and *B*, in the ground until their tops are nearly on the same level. Place

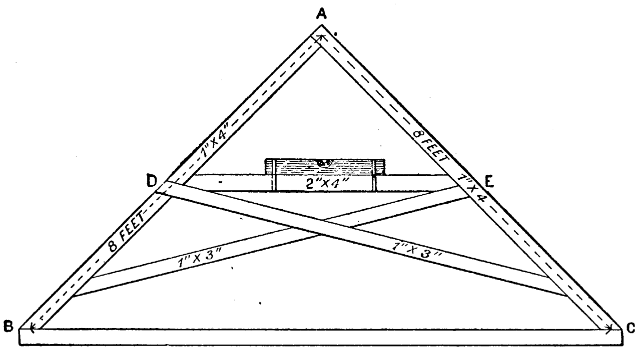



FIG. 66.—Triangle with carpenter's level.

one end, *A*, of the carpenter's level on the stake *A* and the other end, *B*, on the stake *B*. Drive one of the stakes until the bubble comes to the center of the tube. Place the end *A* of the level on the stake *B* and the end *B* on the stake *A* and note the position of the bubble. Reverse the ends of the level to their former position and see if the bubble returns to the center of the tube; if not, repeat the operation. If this can not be brought about, the level should not be considered trustworthy, and should not be used. After finding that the bubble returns to the center satisfactorily, place the end *A* upon the stake *B* and the end *B* on the stake *A* and correct one-half of the apparent error by the set screw which fastens the spirit level to the wood of the carpenter's level. Reverse the ends of the level and drive one of the stakes until the bubble comes again to the center. Repeat this operation until the bubble is in the center in both positions. The level is then in adjustment, and the tops of the stakes are at the same elevation.

Replace the carpenter's level on the frame and the device is ready for use. It should be tested each time before being used. This can be done as follows: The carpenter's level is in adjustment and the upper edge of $BC$ (fig. 66) is a straight line. Place the level on this line and drive two stakes, one at $B$ and the other at $C$, so that their tops are even with the upper edge of $BC$, when the bubble is in the center of the tube. The tops of the stakes should then be nearly level. By reversing the straightedge several times they can be more accurately driven, and any error of the carpenter's level can be eliminated. When the tops of the stakes are on the same level replace the carpenter's level on the frame and make its legs the same length by adding a piece of wood to the shorter one, $BC$. When the legs are set on the stakes the bubble should come to the center of the tube and should not change when the ends of the frame are reversed.

In use, whenever the bubble is in the center of the tube, the leg $B$ will stand on the ground as much higher than the leg $C$ as will give the proper grade to the ditch. The leg $C$ is placed on a hub, a small stake driven flush with the surface of the ground at the lower end of the ditch line. A point 11 feet above on the ditch line is then found where $B$ touches the surface of the ground when the bubble is in the center of the tube. This point is also marked by a hub. These two points mark the grade line of the ditch. The frame is then carried forward, placing the leg $C$ upon the last hub, and this operation is repeated till the ditch line is entirely located. In order that the hubs may be easily found, a small stake is driven beside each.

### SELECTION OF A SITE FOR THE HEADGATE AND THE CHOICE OF DITCH LINES.

Fig. 67 shows the farm, the creek, and the ground over which the ditch is to be built. The grade assumed for the ditch $AB$ is 5 feet per mile, or one-fourth the fall of the creek. Therefore the creek rises, in going upstream, four times as much as the ditch in going the same distance; hence, the line of the ditch will gradually approach the creek. The line and the creek will intersect at a point about 1 mile above the farm or about one-eighth of a mile above $B$.

It frequently occurs, as shown in fig. 67, that the point where the preliminary line intersects the creek is not a suitable one for the location of the headgate. The banks of the creek are high, thus making a deep cut necessary, and owing to a bend in its channel the current is thrown toward the opposite side of the stream. If for any such reasons the ditch can not be cheaply or conveniently taken out, the banks of the creek above should be carefully examined, to see if there is not a more desirable location. Suppose a point, $D$, is found about a quarter of a mile above, where the banks are not high and where an outer curve directs the current toward the headgate. If the stream is subject to sudden and heavy floods, it might be better for the headgate to be located on a straight portion of the channel rather than upon the curve.

After deciding that the headgate should be located at *D*, it is necessary to determine how to carry the water from there to the farm. The headgate *D* can either be connected with some point of the preliminary line, as *B*, or a new line can be run leading directly to the farm, as shown by the upper dotted line *DA*. There are a number of questions to be taken into consideration before a choice between the two lines should be decided upon. Usually the higher the ditch line the rougher the country. Often rock is encountered, and the upper line is generally much more crooked if it follows the surface of the ground. A

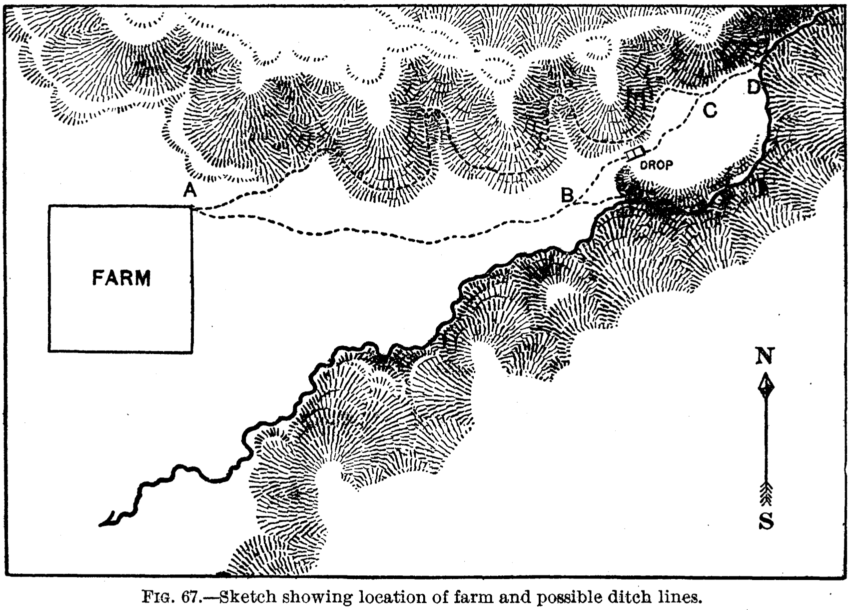



FIG. 67.—Sketch showing location of farm and possible ditch lines.

line run directly from the headgate to the farm has a grade of about 7 feet per mile. However, if this country is more broken than that along the preliminary line, the upper ditch will be crooked, and hence be longer than it has been estimated. This increased length will reduce the grade. Suppose in this case that, after examining the country along the upper line, it is found that a large quantity of rock would be encountered in the construction of the ditch. It is necessary then to go back to the headgate and examine the country between that point and the preliminary line. It is found that a short ditch, *DCB*, running from the headgate to connect with the preliminary line can be built. A uniform grade can be maintained by constructing a drop, located as shown in fig. 67. This compromise between the two lines is therefore decided upon. The fall of water over the drop is $3\frac{1}{2}$ feet, thus allowing a grade of 6 feet per mile in the short ditch. If this precaution were not taken, its channel would be worn away in a short time, and the material thus washed out would be deposited in the lower ditch, from which place it would have to be removed. The drop (fig. 68) consists of a short flume, *D*, with a flaring approach and submerged platform, *A*. The floor *C*, on the grade of the ditch below the drop, breaks the force of the falling water. The flaring wings and submerged

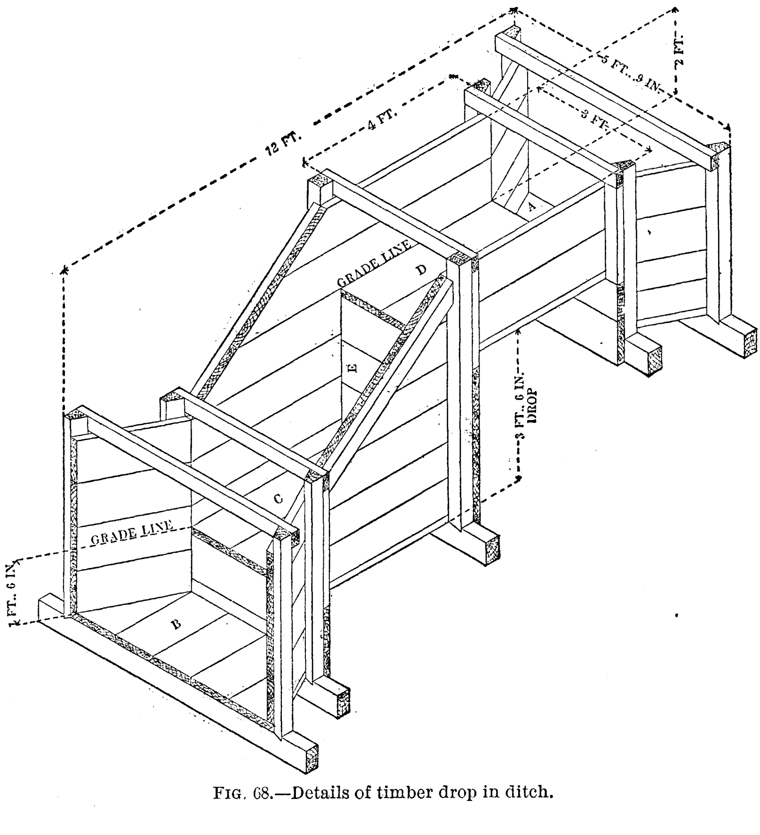



FIG. 68.—Details of timber drop in ditch.

platform at *B* protect the ditch at that point. The dimensions are also shown in fig. 68.

To mark the line of the ditch with a furrow after it has been properly located, let one man guide the team, walking between the heads of the horses and holding a bit in each hand, while another holds the plow. If the surface of the ground will permit a wagon to be driven over the line, the plow may be attached to the rear axle, the driver directing the team from the seat of the wagon. The team is driven in such a direction as to turn the furrow to the lower side of the ditch. If the surface of the ground is comparatively level across the line of the ditch, it is not necessary to follow the stakes closely in the bends. The ditch will be better for being straightened a little, which may be done by going above the stakes that locate the bends nearest the creek and a little below the stakes that locate the bends farthest away. If the ground slopes very much across the ditch line the stakes must be followed closely. After the line is marked, two or three furrows are plowed, turning them to the lower side. A ditch of this size may be built almost wholly with an ordinary plow, by going over the line a number of times. The loose earth in the bottom of the ditch may be removed with a plank scraper, shown in fig. 69. The tongue should be long enough to allow the team to work below the bank. The scraper is lifted over the loose earth as the team

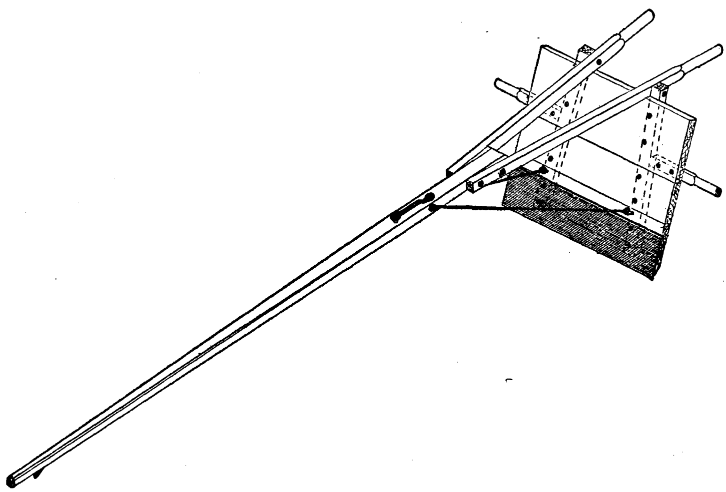


FIG. 69.—Plank scraper.

backs, and the load is dragged out as the team moves forward. A ditch of the size contemplated is rather too small to admit of using the ordinary scraper to advantage.

### HEADGATE.

A small ditch of the kind described might be used for years without a headgate. It will, however, be much better to have one, so the water can be shut off when it is not needed for irrigation.

Fig. 70 shows a common type of small headgate. It consists of a box, or flume, 6 feet long, 3 feet wide, and 3 feet deep, with a gate, *D*, at the end nearest the creek. At both ends the sides flare at an angle of about 30°. Under them, 1½ feet below the floor of the structure *C*, platforms *A* and *B* are built. Both of these platforms are covered with earth to the level of the floor *C*. Earth is also carefully tamped around the outside of the headgate.

All precautions should be taken to prevent water from working along the outside of the headgate. The structure may be undermined in a short time if only a small stream finds its way between the planks and the earth. The flaring wings and submerged platform are built to prevent this action, and also to make the structure secure in case of high water.

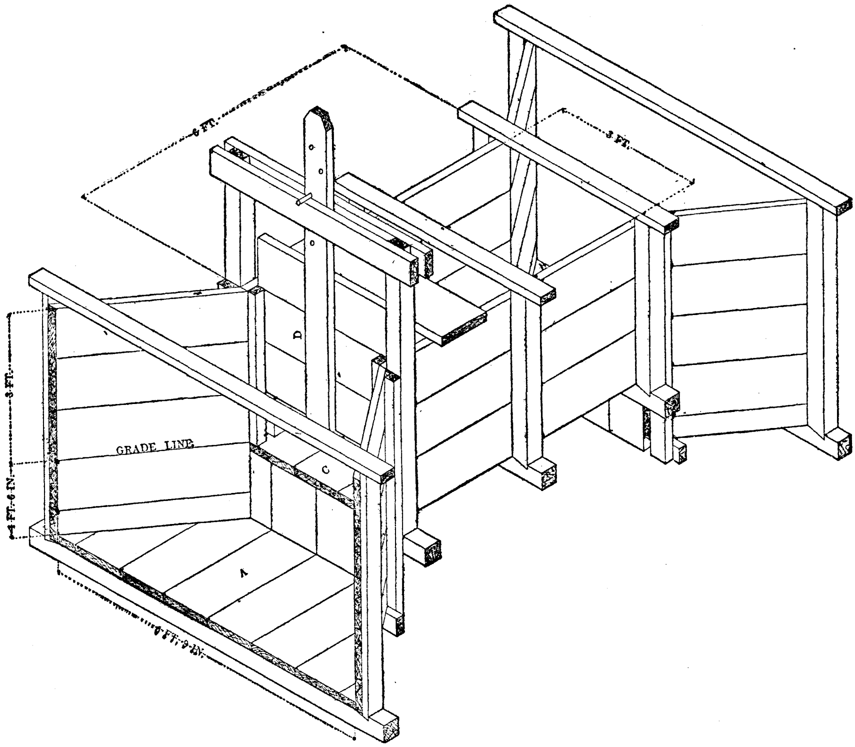



FIG. 70—Details of headgate.

## LAYING OUT FIELD LATERALS.

The location of the laterals furnishes an opportunity for the irrigator to show his skill. While the land is new, spreading water over it will be a difficult matter. It may be impossible to properly locate the main laterals at first, and supplemental laterals and dikes may have to be constructed. Before the crops can be harvested these temporary channels must be filled in and the ground leveled. Theoretically, they should be given such a grade as will result in a moderate velocity for the water, but not sufficient to wash the earth along the sides and bottom of the ditch. One irrigator of considerable experience recommends that field laterals should have a fall of at least 10 feet per mile. The laterals should be located nearly at right angles with the direction of the greatest slope of the land, so that water will flow from rather than along them. Mistakes have been made in constructing them parallel with the steepest slope. When the water is turned from these it tends to follow rather than to flow away from them, thus adding greatly to the work of the irrigator. If the surface of the ground is somewhat uneven the problem of locating the permanent laterals becomes correspondingly more difficult, often rendering the use of the engineer's level necessary. It may be possible to cover all the ground by locating the laterals along the ridges, or there may be high points entirely surrounded by lower ground, making it necessary to build ditches on artificial ridges, or dikes, to carry the water to them. The inexperienced irrigator often considers that the

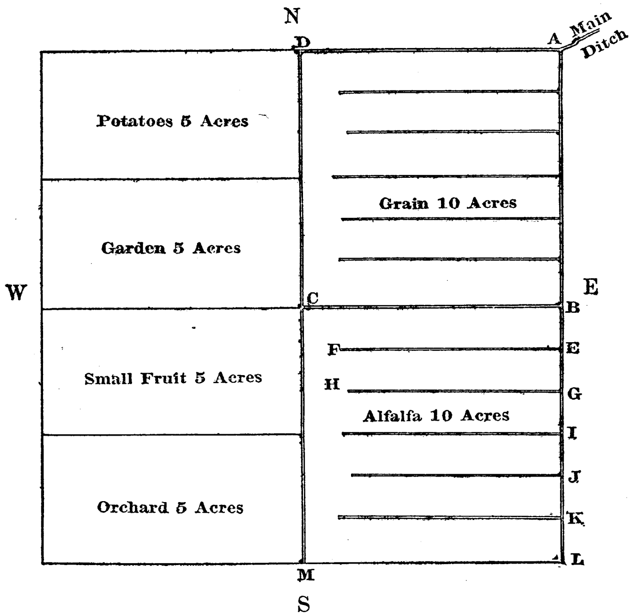



FIG. 71.—Plat of farm, showing laterals.

ground occupied by the laterals is waste land, because it bears no crop. Accordingly, he makes them far apart, so that the water must flow a long distance to cover the surface between any two. This usually results in the overirrigation of that portion of the crop near the lateral in use, as the water must be kept flowing there until the entire surface to the next lateral is irrigated.

It will usually pay to do some work in smoothing off the little irregularities in the surface of the farm. This may be done with a plank scraper, or drag, after the ground has been plowed. The drag cuts away the higher points and leaves the dirt in the hollows. This preparation of the surface is quite important, as it reduces the time and labor required in irrigating. A more uniform distribution of water is also obtained, which increases its efficiency. Theoretically, the surface of the ground should be a plane surface, with just slope enough to allow the water, when delivered at the highest point, to flow in a thin, uniform sheet.

We will assume that the farm is planted to such crops as are ordinarily found in the arid region, say 10 acres of alfalfa, 10 acres of grain, 5 acres of potatoes, 5 acres of garden, 5 acres of small fruits, and 5 acres of orchard, as shown on the plat of the farm. (Fig. 71.)

If it be assumed that there is a fall of 4 feet across the farm from north to south and 2 feet from east to west, the water can be made to flow either west or south from any point. The greatest slope of the land is a little south of southwest, and this is the direction the water takes if left to itself. If the laterals are run south from the main ditch they will make an angle of about 70° with this line. Such an arrangement permits the water to flow away from rather than along the laterals. The main ditch divides at *A*, as shown in fig. 71; one branch runs south to *L*, while a second runs west to *D*, the middle of the north line of the farm, where it turns and flows south to *M*. The field laterals receive their supply of water directly from these ditches.

## METHODS OF APPLYING WATER TO CROPS.

Alfalfa is irrigated by the method known as flooding, which may be described as follows: Nearly parallel ditches, *BC*, *EF*, etc., are made 100 to 150 feet apart through the field. In the present case six ditches are made, 110 feet apart, dividing the field into six strips. As these laterals will remain as long as the field is in alfalfa, we may put division boxes (see fig. 72) at *B*, *E*, *G*, etc., where the laterals are taken from the main ditch. This will avoid cutting through the ditch bank and refilling with earth when the water is changed from one lateral to another. The division box is simply a short flume placed in the ditch with a channel leading away, usually at right angles. Vertical cleats are provided for holding flashboards in place for checking the water. These boards may be placed either in the branch or the main ditch as desired.

The division box at *A* (fig. 71) is set so the water will flow to *B*. At this point the division box is so adjusted that water runs into the lateral (*BC*), and the lower bank of the lateral is cut a few feet from *B*. Just below the cut a canvas dam is thrown across the ditch to force the water over the surface of the ground. The canvas dam is a piece of heavy cloth, 5 or 6 feet long and 3 or 4 feet wide, one edge of which is tacked to a pole long enough to rest on the banks as it is thrown across the ditch. The cloth rests against the bottom and sides of the ditch above the pole, where two or three shovelfuls of dirt are placed to hold it in position. When the water from lateral *BC* flowing over the surface reaches the lateral *EF*, entirely covering the intermediate area, another cut is made in *BC*, 100 to 150 feet farther from *B*. The canvas dam is again used to check the water, which is allowed to flow out as before. This operation is repeated till the entire surface of the first strip has been covered. The division box at *B* is then set to shut the water from the lateral *BC* and allow it to flow to *E*, where it runs into the lateral *EF*, and from it over the surface of the next strip. In this manner strip after strip is irrigated, till the entire field is covered. The field laterals are not as large as the main ditch, and it may be necessary to divide the water between two or more of them. Assuming that it will require a quantity of water sufficient to cover the field to a depth of 6 inches, in order to give it a thorough irrigation,

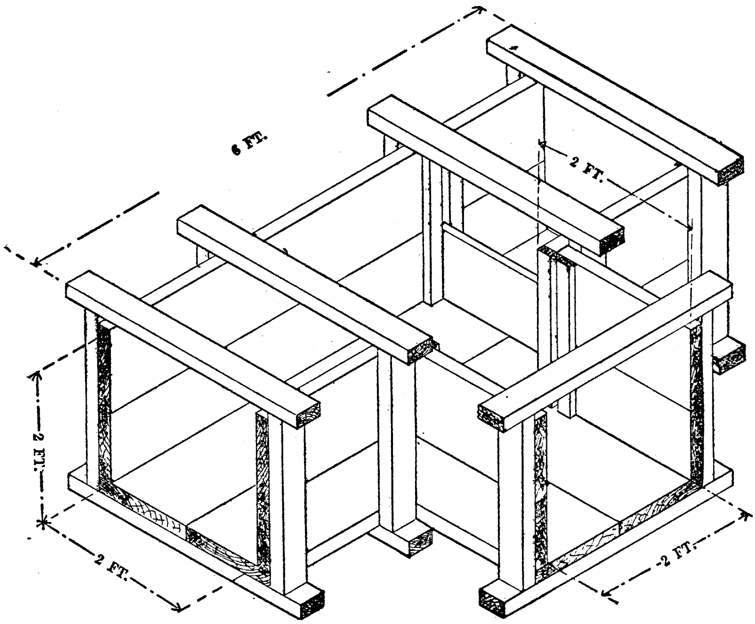



FIG. 72.—Details of division box.

it will take about twenty-four hours to irrigate the entire field. The ditch must carry $2\frac{1}{2}$ cubic feet of water per second to accomplish this.

The grain crop is irrigated in the same manner. The laterals in the grain field may be made about the same distance apart as those in the alfalfa field. They may be built with an ordinary plow by turning two furrows away from each other, or they may be made with a special plow having two moldboards. This tool throws the dirt out of the ditch on both sides and completes the lateral in one operation. These laterals are used only for the one crop, and are filled with the plow just before harvest, so that the binder may cross them in cutting the grain. If the grain is sown with a drill running east and west the small furrows made by it form miniature ditches, which the water follows.

The irrigator must see that the water reaches those places where, on account of elevations or obstructions, it does not run readily.

For the irrigation of the crops on the south half of the farm, furrow irrigation is employed. The potatoes are planted in rows and are "furrowed out" before being irrigated. This is done by running a shovel plow between the rows, making small ditches, into which the water is turned and allowed to flow until it has reached the other end of the field. The water is "set" on a certain number of rows, allowing only a small stream to flow in each. The surface is not flooded, but the water is confined to the furrows and percolates laterally into the soil. The water is taken out of the permanent lateral *DM* at the corner of the field and carried along in a temporary ditch parallel to it. After a strip 100 to 150 feet wide, containing 40 or 50 rows, has been irrigated from the first opening, the main lateral is cut farther down, and the process is repeated. The garden may be irrigated in a manner similar to that described for the potatoes.

The small fruits and the orchard are crops of a more permanent character, and will occupy the same ground for a number of years. For these reasons division boxes are placed in the main lateral where it is desired to take out water. Ordinarily, small fruits are irrigated by the furrow method. It is thought better practice by many irrigators to allow a small stream of water to flow between the rows for a considerable time than to allow a large stream to run for a short period. This gives more opportunity for the water to soak into the soil, leaving it in the same condition as does a heavy rain.

The orchard is irrigated either by flooding or by furrows. Of the two, the furrow system is perhaps more often used. Parallel furrows 3 to 6 feet apart are made and small streams of water are allowed to flow in them until the ground is thoroughly saturated.

In some localities the best results are obtained from the orchards when the entire surface of the ground is flooded. Care is taken, however, to keep the water away from the trees, as it is found that they thrive better when the water does not touch them, but percolates into the soil and reaches the roots. When all of the ground between the trees is moistened the roots spread uniformly. Where furrows are used for irrigating orchards they are often plowed under after water has been applied. The ground is then leveled and the surface finely pulverized. As long as the surface of the ground remains in this condition evaporation is greatly reduced. This method requires considerable work, as the laterals have to be made some time prior to the irrigation of the orchard.

There are other methods for applying water to crops, but all of them require a more elaborate preparation of the surface of the ground, and need not be described here.

When it is possible, cultivation should follow each irrigation as soon as the ground is dry enough to be worked. If all crops could be cultivated in this way the amount of water which would have to be applied would be greatly reduced. The duty of water is uniformly small for corn, potatoes, orchards, and other crops which can be easily cultivated. If the ground can not be cultivated after it has been irrigated, the surface will often bake. This is injurious to some kinds of plant growth, and evaporation is thereby greatly increased, making another irrigation necessary much sooner than it would otherwise be.

### WHEN TO IRRIGATE.

In order to determine just when crops need water and when to apply it so that they will not suffer from drought, nor be injured by too frequent or too generous applications, requires a knowledge and experience that can be gained only by practice and a close observation of various crops under irrigation. It is the experience of many practical irrigators that, if an unlimited supply of water is available, crops more frequently suffer from overirrigation than from drought. It is difficult to determine when the development of the crop is first arrested on account of a lack of moisture in the soil. Some experimenters maintain that this point can be more definitely decided by an examination of the soil than by the appearance of the plant, as the latter shows evidence of the check in its growth some days after it has occurred. Usually it is then too late to prevent serious loss, as the crop rarely recovers from such treatment and seldom reaches the development it would have attained if it had been irrigated at the proper time.

Plants will usually indicate by a change in color or by their general appearance whether they need water or when they have been overirrigated. Most field crops turn to a darker green when in need of water, and the leaves and stems show a tendency to droop or curl. The lower leaves assume a pale yellow. A crisp or dead appearance in the lower leaves is one of the best indications that a plant needs water. Grain which has suffered from drought may mature, but the straw will be small and short and the kernels will be shrunken and inferior in quality. Alfalfa and similar crops have the appearance of cured hay. Where field crops are overirrigated the color of the foliage becomes a yellowish green and the plants have a sickly appearance. These indications vary with the quality of the soil, so that it is impossible to lay down fixed rules to govern the number or frequency of irrigations. Only close observation for a number of years on the same farm will enable a person to tell by the appearance of the plants whether they need water or not.

The amount of moisture in the soil may be determined with sufficient accuracy for the needs of the plant by examining a sample taken a few inches from the surface of the ground. If it clings together when molded in a ball and shows the print of the fingers, there is moisture enough present. If the earth falls apart when the hand is opened, irrigation is needed. As stated above, this point is passed some days before the plant shows indications of suffering.

### COST OF BUILDING AND MAINTAINING A DITCH.

The cost of a small system of irrigation similar to that already described may properly be considered here. The ditch is $1\frac{1}{4}$ miles long, and the main laterals on the farm are of the same cross-sectional dimensions, and are five-eighths of a mile long. The laterals in the alfalfa and grain fields have a total length of $1\frac{1}{4}$ miles, and are slightly smaller. A short calculation shows that nearly 1,250 cubic yards will have to be moved in the construction of these ditches. This volume at 5 cents per cubic yard makes the cost of the work $62.50. The headgate requires 360 feet B. M. of 2-inch planks and 2 by 4 inch scantling, at a cost of $15 to $18 per thousand. The 30 division boxes are made of 2-inch lumber and require nearly 4,000 feet B. M. The headgate, drop, and division boxes will cost, in place, not far from $125. This will make an investment of about $200 in the completed ditches.

It has been demonstrated by experiment that it requires a volume of water sufficient to cover the area to a depth of 2 or 3 feet to mature ordinary field crops. Basing the calculation on these figures, and assuming that there is no rainfall during the irrigation season, it will require an aggregate of from sixteen to twenty-four days to complete the work of irrigation if the ditch delivers $2\frac{1}{2}$ cubic feet of water per second and the work is carried on day and night. Assume that twenty days is a mean period for this work, the cost of irrigation therefore approximates $1 per acre. Since some crops require that the water be watched continually during irrigation, the cost per acre is increased somewhat owing to the necessity of employing a man to work at night. The average cost probably does not exceed $1.20 per acre.

After the first year the cost of repairs will amount to something like 10 per cent of the original outlay in building the ditch, or about $20.

The following summarizes the original cost of the ditch and laterals and the yearly outlay for repairs and labor:

*Cost of ditch and laterals.*

| | |
|---|---|
| Making level and running line | $12.00 |
| Cost of excavation of ditch and laterals | 62.50 |
| Cost of headgate, drop, division boxes, etc | 125.00 |
| Total | 199.50 |

*Yearly cost of irrigation and maintenance of ditches.*

| | |
|---|---|
| Labor in irrigating | $48.00 |
| Repairs to ditches | 20.00 |
| Total | 68.00 |

In the above estimate the labor has been included at average prices for such work. If the farmer has time to do the work himself, his only cash outlay will be for lumber.

# FREE DELIVERY OF RURAL MAILS.

By Charles H. Greathouse, M. A.,
*Editorial Clerk, Division of Publications.*

## RAPID GROWTH OF RURAL FREE DELIVERY.

The system of free delivery of mail at the farm homestead is developing in the United States by great strides. It is commonly known as "Rural free delivery." The first routes bearing this name were established on October 1, 1896, at Halltown, Uvilla, and Charlestown, W. Va. Others followed at once, and by the close of the fiscal year the experiment showed satisfactory results. There were 44 routes in the fall of 1897; this number increased to 128 in 1898, and on November 1, 1899, had jumped to 634. These radiated from 383 distributing points and served a population of 452,735 persons. On June 30, 1900, a little more than six months later, the number of routes had grown to 1,214 for a population of 879,127, and in the next four months the system again more than doubled its proportions, showing on November 1, 1900, 2,551 routes for 1,801,524 persons; and there were also at that date 2,158 applications for the establishment of new routes.[1] The whole of the United States is now laid out in four divisions for the inauguration and maintenance of this service, and the work is going forward with steadily increasing volume. (See figs. 73 and 74.)

President McKinley in his message to Congress of December 3, 1900, states that "the number of applications now pending and awaiting action nearly equals all those granted up to the present time, and by the close of the current fiscal year about 4,000 routes will have been established, providing for the daily delivery of mails at the scattered homes of about three and a half million of rural population." The President describes this as the most striking new development of the postal service, which "ameliorates the isolation of farm life, conduces to good roads, and quickens and extends the dissemination of general information." He adds that "experience thus far has tended to allay the apprehension that it would be so expensive as to forbid its general adoption or make it a serious burden; its actual application has shown that it increases postal receipts, and can be accomplished by reductions in other branches of the service, so that the augmented revenues and

[1] The applications for new routes on March 1, 1901, numbered 4,517. The figures, by States, are given in the Appendix to this Yearbook.

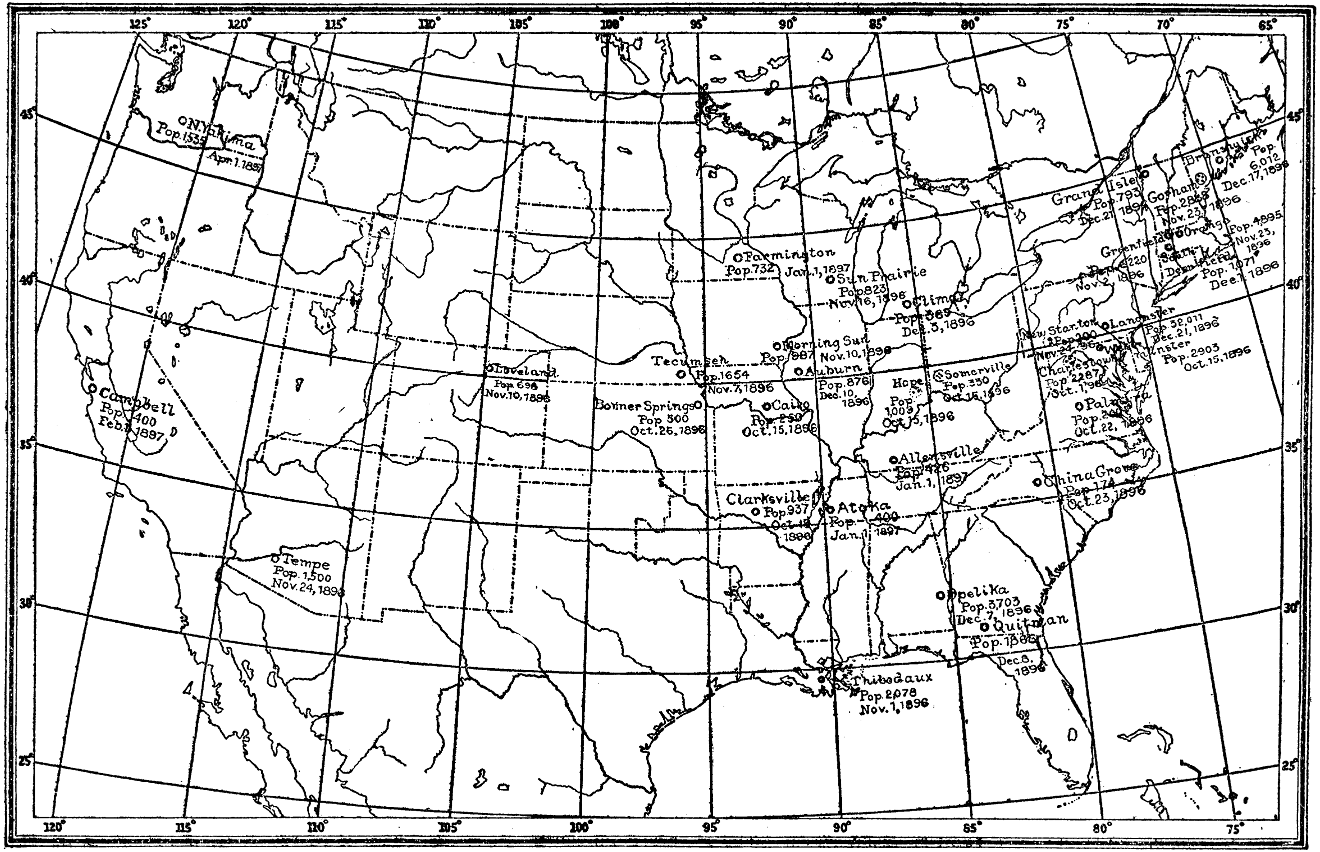



FIG. 73.—Rural free-delivery routes April 1, 1897, the first established; population of the census of 1890; dates of establishment of the service are given.

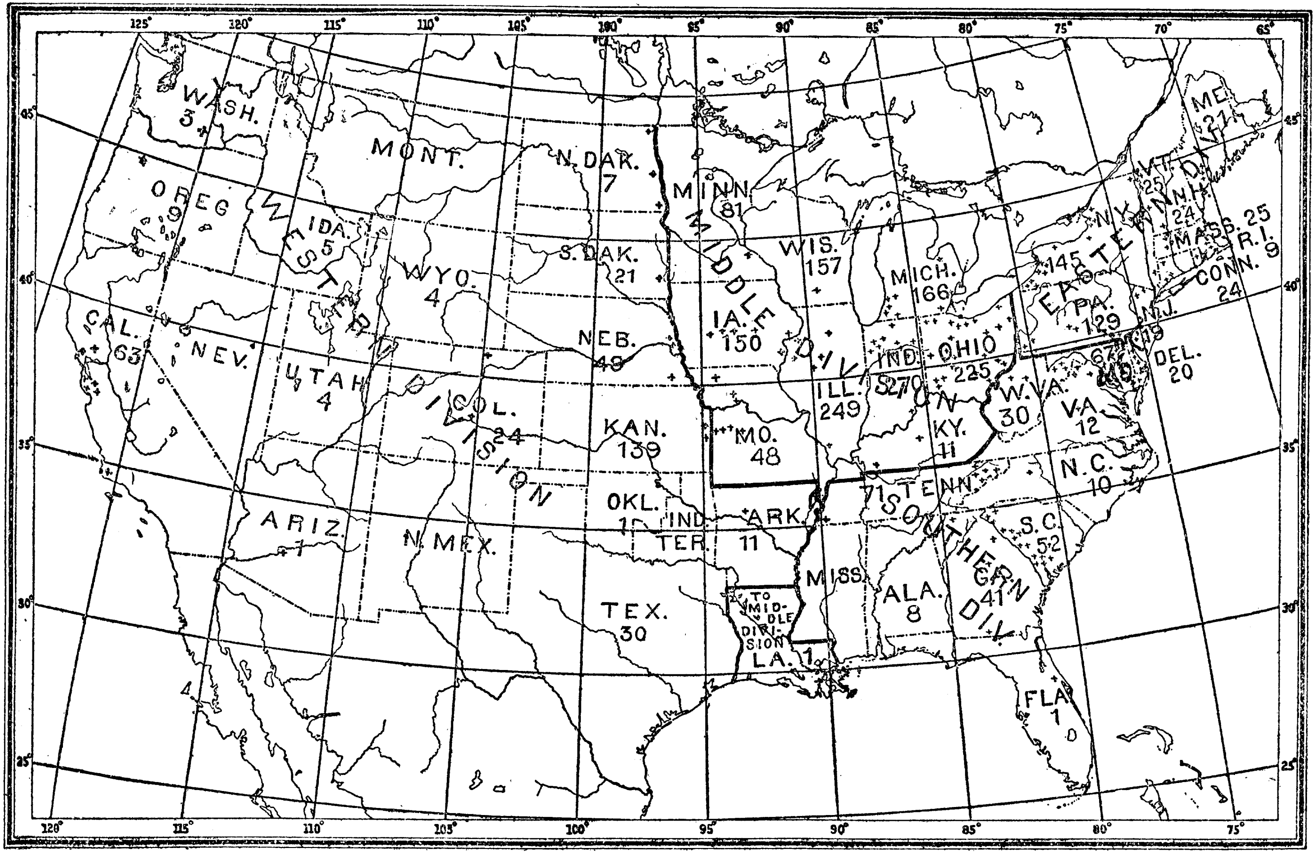



FIG. 74.—Rural free-delivery routes November 1, 1899, indicated by crosses (+); large numerals give numbers of routes in each State on June 30, 1900.

the accomplished savings together materially reduce the net cost." All these results, the President says, "have come almost wholly within the last year."

The first appropriations for the service, $10,000 for the fiscal year 1894, $20,000 for 1895, and $30,000 for 1896, were not used. Subsequent appropriations have been as follows: For 1897, $40,000; for 1898, $50,000; for 1899, $150,000; for 1900, $450,000; for 1901, $1,750,000. The Post-Office appropriation bill approved March 4, 1901, carries $3,500,000 for this use in the fiscal year 1902.

### HISTORY OF THE DEVELOPMENT OF RURAL FREE DELIVERY.[1]

Undoubtedly the evolution of the rural free-delivery service as it now exists dates back to "village delivery" which Postmaster-General Wanamaker recommended in 1890. The service he inaugurated, however, was not a "rural" delivery, but an extension of the city delivery system by carriers on foot in towns with a less population than 10,000, or less gross postal receipts than $10,000, the limit at which city delivery stops under existing law. The broad recommendations included in Mr. Wanamaker's report for an abandonment of the old colonial postal system (recently most aptly described by Postmaster-General Charles Emory Smith as a plan which "required the man to go for the mails, instead of the mails going to the man"), aroused public attention, and started an agitation in Congress and by the people for an extension of the free-delivery system into hitherto untried fields. When, on a change of Administration, the village-delivery experiment inaugurated on Postmaster-General Wanamaker's recommendation was ordered by Congress to be discontinued, after a brief experimental existence of little more than two years, the movement for free delivery on a broader basis was not suspended, but grew in intensity.

The new agitation took the form, not of a request for free delivery in villages where none of the patrons lived more than a mile or so from their village post office, but of a movement to give country delivery to farmers who lived from 2 to 12 miles from any post office, and who in consequence had to waste the best part of a day whenever they wished to mail a letter or expected to receive one, or desired to obtain a newspaper or magazine for which they had subscribed.

The State granges of Patrons of Husbandry took up the subject and brought strong pressure to bear upon Representatives in Congress from agricultural communities. Under these incentives a number of small appropriations were passed, but, as already stated, were not used. The prevailing sentiment, both in Congress and among the

[1] All data relating to the early history and development of the rural free delivery were supplied and revised by the Post-Office Department, to whose courtesy this acknowledgment is due.


FIG. 1.—RURAL DELIVERY IN SUMMER, NEAR JAMESTOWN, KANS.


FIG. 2.—RURAL DELIVERY IN WINTER, NEAR CONCORD, N. H.

executive officers of the Post-Office Department, as then constituted, was that the plan of rural free delivery was impossible of general adoption, and that it would cost at least $20,000,000 a year to establish and maintain it.

CONGRESSIONAL ACTION.

Postmaster-General Wilson S. Bissell declined to make any use of the small appropriation of $10,000 for experimental rural free delivery in 1894. His antagonistic views were concurred in by the Committee on the Post-Office and Post-Roads of the Fifty-third Congress, Hon. John S. Henderson, of North Carolina, being chairman. But many Representatives had become strongly interested in the project, and in spite of the committee's adverse report, the appropriation was doubled. Mr. Bissell, however, again refused to act, and it was not until after Hon. William L. Wilson became Postmaster-General that anything was done to comply with the directions of Congress. Mr. Wilson was appointed in the spring of 1895. In his first report he said that he had taken charge too late in the fiscal year to undertake the work. He agreed with his predecessor, Mr. Bissell, that the proposal was impracticable, but he added that if Congress chose to make the money available for the fiscal year 1897 he would inaugurate the experiment by the best methods he could devise. The response by Congress was a second doubling of the appropriation, putting $40,000 at his disposal.

THE FIRST ROUTES ESTABLISHED.

Under this authorization, 44 routes were selected in widely differing localities in 29 States. The purpose was to make the experiment as general as possible, and to have the result represent the working of the system under as diverse conditions as possible. Fifteen routes were set going in October, 1896, 15 in November, 8 in December, 3 in January, and 1 each in February and April following. Some of these routes were in the foothills of the Alleghenies about Charlestown, W. Va., others on the prairies of Kansas and Nebraska (Pl. LXIII, fig. 1); some among the sugar plantations of Louisiana, others among the snow and ice of Grand Isle in Lake Champlain and on the wind-swept plains of Minnesota; some were in the populous old communities of northern Massachusetts and southwestern Maine, others among the fruit orchards of Arizona and the grass lands of southern Washington. The other States represented were Indiana, Ohio, Maryland, Missouri, Arkansas, Virginia, North Carolina, Colorado, Iowa, Pennsylvania, Michigan, Alabama, Georgia, Kentucky, Illinois, Tennessee, and California.

UNFAVORABLE CONDITIONS.

It was dead of winter before the work got fairly under way, so that the difficulties were practically at a maximum, except that of muddy roads, which would become more and more impassable as spring came on.

The officials who were intrusted with the inauguration of the service were often dissatisfied and unfavorably disposed toward the work, because they had to be detailed from their regular work in such a way as to hinder their probable promotion. Accordingly some of the first reports were quite discouraging.

The inspector who laid out the route at Hartsville, Ind., wrote that the people who were reached were not asking for delivery of their mails at their homes. Their correspondence was mainly social, not demanding promptness of delivery, and only farmers living near the post office took daily papers. "The importance of the average farmer's mail," he said, "is not such as to make rural free delivery essential." The fact that the farmers near the post office took daily papers seemed to give no intimation to this inspector that free delivery would cause farmers all along the route to do the same thing.

### ADOPTION BY THE EXECUTIVE OF VIEWS FAVORABLE TO THE SYSTEM.

In consequence of the discouragements just referred to, the new service was so little known when Hon. Perry S. Heath became First Assistant Postmaster-General in March, 1897, that he learned with some surprise that a trial was actually being made of rural free delivery. He took charge of the administrative division to which the experiment belonged, and determined to go into the matter exhaustively. In contradiction of the unfavorable reports from some of the agents in charge of the work came good news from other agents, and the sentiment of farmers everywhere seemed favorable to a thorough test of the system. Congress was so well satisfied with the success so far attained that the appropriation for 1898 was made $50,000.

Mr. Heath said in his second report to the Postmaster-General:

> An examination of the reports on file led to the conclusion that great possibilities of social, industrial, and educational development lay behind the projected extension of postal facilities in rural communities, and that with proper care in the selection of localities, the service could be extended far and wide, with great benefit to the people and without any serious tax upon the revenues of the Government, inasmuch as the increase of postal business which had hitherto followed the granting of additional postal facilities in every well-selected rural route would go far toward the payment of the extra expense incurred, while the discontinuance of unnecessary post offices and star routes would in many cases make the improved service a source of saving instead of added outlay.
>
> It was, of course, apparent that no accurate balance sheet of profit and loss could immediately be struck, inasmuch as no account could be kept of the saving effected by dispensing with the offices of postmasters of the fourth class, who are authorized by law to retain all their receipts up to the limit of $1,000. Their receipts do not appear in the post-office returns. They are perquisites of the postmasters, to which they cling with natural tenacity. When, under the operations of rural free delivery, their cancellations are turned into the general postal revenues, the service thus rendered becomes an item of cost charged against the rural free delivery appropriation, but the saving effected can not be credited to that account. In like manner star-route service dispensed with makes a net saving to the Government, but goes to

the credit of another branch of the service, as star-route contractors are paid under an appropriation not supervised by the First Assistant Postmaster-General.

Petitions from every section of country where the service had been given a fair trial began to pour in upon the Department. Special agents were appointed to look into the claims presented and to lay out services wherever the conditions seemed favorable to an economical and successful administration. Such good results were obtained that Congress, responding to the demand of the people, appropriated $150,000 for rural free delivery for the fiscal year 1897–98 [1898–99], and gave $300,000 for the same purpose for the current fiscal year [1900]. The requests for the service multiplied like an endless chain, every new rural delivery route established bringing in three or more applications from contiguous territory for like privileges, and before four months of the present fiscal year had expired the appropriation was found to have been practically apportioned out, that is to say, the existing service, if continued to the close of the fiscal year, would require the disbursement of the whole amount appropriated by Congress. As I did not deem myself authorized to create a deficiency, even in so popular and important a work of postal development, a halt was reluctantly called in the installation of new rural free delivery service to await the further directions of the Congress.

### OPPOSITION OF POSTMASTERS AND STAR-ROUTE CONTRACTORS.

It must not be supposed, however, that all opposition to rural free delivery ceased with the change of attitude on the part of the Post-Office Department. It was found by the special agents in charge of the establishment of new routes that considerable sentiment against the change of method was manifested in some communities where it was about to be made. In several cases petitions were sent to Congress making protest, but upon investigation it was found in most cases that this adverse feeling had been worked up in the interest of a fourth-class postmaster or a star-route contractor who was likely to be displaced by the new routes. In some cases the fear of the postmaster was supplemented by apprehension among his village neighbors that trade would go elsewhere. In many instances signers of petitions, when called upon, repudiated the views they had been induced to indorse. They had signed out of good will to their neighbors and with little attention to the meaning of the petition. When the question of free delivery was brought before them on its merits they had little to say in opposition, and when it was presented as a direct benefit to themselves they were active in preventing the choice of some other section than their own for the location of the next new route.

### THE SYSTEM PUT TO A TEST.

Congress without hesitation supplied the additional funds called for by the unexpectedly rapid growth of the service, and the installation of new routes went speedily forward.

Up to this point the service had been fragmentary and detached. It was Postmaster-General Smith who developed the idea of putting the service to a test of practicability by extending rural delivery over an entire county, superseding all other service, and then striking a balance sheet of profit and loss.

Four lines of investigation were laid down:

(1) To what extent can rural free delivery supersede fourth-class post offices and star routes.

(2) To what extent can it be used as a channel through which to extend to the farmer all other postal facilities, as money orders, etc.

(3) What will be the effect on the postal revenues.

(4) What the net cost to the Government as compared with that of the old system.

It seemed essential that such an experiment should be made in a strictly farming community, presenting many of the topographical and other physical conditions and obstacles likely to be encountered in a general introduction of the service elsewhere, so that its successful operation under such circumstances might be looked upon as a guaranty of its success in any other average rural locality in which it might be established.

### THE CARROLL COUNTY SERVICE.

Carroll County, Md., was selected, with the third-class post office of Westminster as the distributing point. The results of the experiment are thus described in official reports of the Post-Office Department:

On December 20, 1899, when winter weather and snowstorms had put the roads in their worst condition, the practicability of establishing rural free delivery to extend over a wide area to the exclusion of all other service, was put to a test in Carroll County, Md. By order of the Postmaster-General, 63 minor post offices and 35 services by star-route contractors and mail messengers were discontinued, all in one day, and rural free delivery substituted in their place.

The Westminster service started with four 2-horse postal wagons, each equipped with all the appliances of a traveling post office, each accompanied by a postal clerk empowered to issue money orders, register letters, and deliver letters, and cancel stamps on letters collected. These wagons supplied mail at designated points to twenty rural carriers, for whom cross routes were laid out, so as to bring all the territory embodied in the order within easy reach of the mails. The initial service in Carroll County covered 387 square miles of the 453 square miles within the county limits. It has since been extended so as to cover the whole county and about 200 square miles of adjacent territory in Baltimore, Howard, Frederick, and Montgomery counties, Md., and York and Adams counties, Pa., this additional service being equivalent to ten ordinary rural free-delivery routes.

The total number of carriers employed is 45, and they, with the four wagon services, give a daily dispatch, as well as delivery, on every route except four, which are too far removed from railroads to be able to make connections the same day; but all letters from these points are dispatched early the following morning.

A detailed report of this service from the Superintendent of the Free Delivery System, under whose direct supervision the experiment was started, was laid before Congress on the 23d of April, 1900. It was shown by this report that during the first three months the cost of the service was $4,543; the saving by service superseded was $2,805; the increase of postal receipts directly resulting from the increased accommodation was $1,501.75, thus leaving the net cost of carrying the postal service practically to, or near to, the homes of all the people in Carroll County for one-quarter of a year only $263.

FIG. 1.—RURAL-DELIVERY CARRIER AT MINING CAMP ON MOUNTAIN ROUTE, BINGHAM CANYON, UTAH.

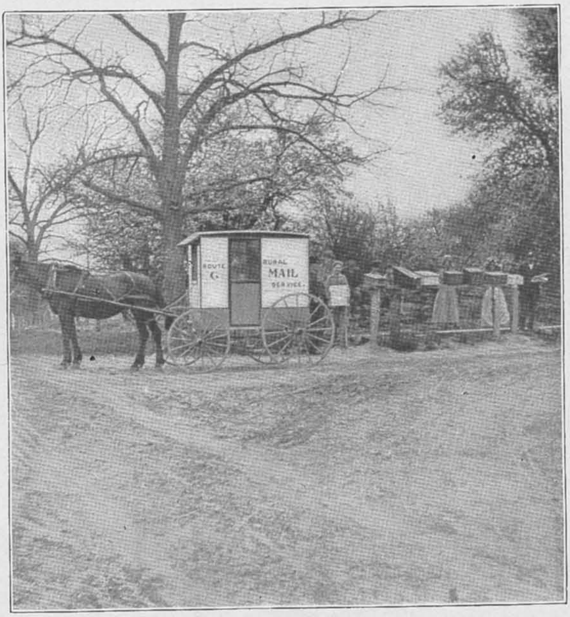



FIG. 2.—MAIL WAGON AND FARM MAIL BOXES AT DUNKARD CHURCH, NEAR DEFIANCE, OHIO.

### OTHER COUNTY SERVICES.

County services on an almost equally broad scale have since been successfully inaugurated in Washington County, Tenn., Washington County, Pa., Fairfield County, Conn., and are in process of installation in other States.

### IMPROVEMENTS, PHASES, AND INCIDENTS.

The practical test of rural free delivery gave rise to many problems, and some of these are even now only in process of settlement.

### MAILS FOR MINING CAMPS.

Among others, was the question what could be done for mining camps and similar customers of the post office. When the service was started only the farming population was considered, but it was soon evident that in several Western States settlers on mineral lands ought not to be left out of the account. What has been actually done is to establish routes for such communities the same as in agricultural sections. (Pl. LXIV, fig. 1.) This service is maintained under a ruling of the Post-Office Department that the term "rural" means "communities not included in cities or incorporated villages, and does not necessarily imply that persons so situated should be engaged in farming in order to obtain the benefits of rural free delivery."

### PROTECTION OF MAIL BOXES.

Another difficulty lay in the danger of loss of mail from boxes not directly owned by the Government and therefore completely under the protection of the statutes. It is not easy even under the most favorable conditions, to secure convictions of offenders against the Government; the lawyers for the defense in such prosecutions are prone to make use of any technicality and as a result, guilty persons often go clear. It was decided by the Department that boxes set up for farm delivery and accepted by the postal authorities as "secure and appropriate" should be regarded as within the application of the law forbidding any tampering with mails. There have been several cases of meddling with the free-delivery boxes, and one man has been held for trial in the United States courts. Further legislation has been asked of Congress so as to supply more convenient boxes to be owned by the Government and thus protected more certainly.

In comparing rural free delivery with the old system as regards safety of the mails, it must not be forgotten that abuses and carelessness are not infrequent at fourth-class post offices. At some places the mail sack is simply emptied on a table and each person hunts through it for his own mail.

### REGISTERED MAIL, MONEY ORDERS, AND DROP LETTERS.

On April 12, 1900, an important advance took place. Rural carriers were authorized to receive and deliver registered mail. As the law requires such matter to be delivered personally, the carriers are obliged to go to the houses instead of dropping the letters or packages in the farm box. Rural carriers are also authorized to receipt for applications for money orders, and while they can not yet issue the orders, they can save the farmer the trip to the office by acting as his agent.

Another most satisfactory change was made on July 26, 1900, when an order was made under which postage on drop letters on rural free-delivery routes was fixed at 2 cents per ounce and carriers were required to cancel stamps on all letters collected by them. This order carried with it authority to deliver drop letters without passing them through the hands of a postmaster.

### ADAPTABILITY OF THE SERVICE.

The effort in the incipiency of the institution of rural free delivery to put the matter to the test under as diverse conditions as possible resulted early in showing that the new way could be adapted to any section not altogether too sparsely settled. It was found possible to deliver the mails in the coldest winter of any part of this country and in the driest and hottest summer with very little interruption, scarcely more than occurs in cities by reason of snowdrifts and washouts on railways. When a heavy snow (Pl. LXIII, fig. 2) blocks the way of the rural carrier it is customary for the farmers to turn out and break the roads, and this is done several days earlier than would be the case ordinarily. In this way communication throughout neighborhoods and with the outside world is opened up promptly. In consequence the farmer is able to take advantage of good markets and the townspeople are not cut off from the supply of fresh country produce, as often has happened in severe storms. Also cases of distress in isolated farm homes are sooner reached and relieved.

The carrier's outfit is modified to suit the conditions under which his work is done, a light vehicle (Pl. LXV, fig. 1) being used in one section while a heavier wagon is preferred in another. The Washington officials have been surprised at the rapidity of the growth of the system in remote and comparatively sparsely settled regions in the West and South (Pl. LXVI).

## ADVANTAGES OF RURAL FREE DELIVERY.

### THEORETICAL CONSIDERATIONS.

Rural free delivery of mails is scientific. On purely theoretical grounds the post office ought always to deliver the matter intrusted to it at the door of the addressee. The distance to be traveled from sender to receiver of mail is precisely the same whether the whole trip be made by the postal employee or he be met part way by the person for whom it is intended. Furthermore, the cost of making the trip is


FIG. 1.—LIGHT EQUIPMENT FOR RURAL DELIVERY, LOS GATOS, CAL.

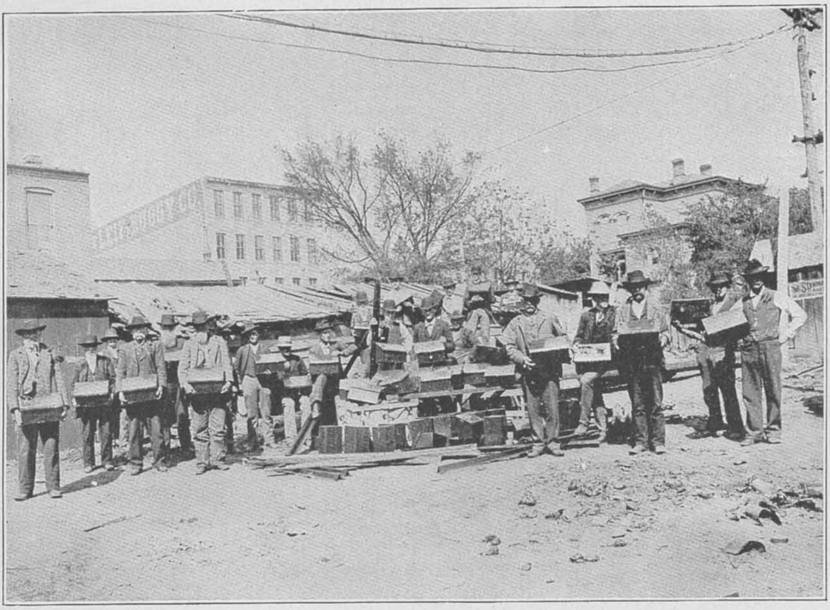


FIG. 2.—A CROWD OF FARMERS DEPARTING WITH THEIR BOXES FOR RURAL ROUTE AT ATTICA, IND.

Plate LXVI.


Mail Wagons ready to Start, at Hillsboro, Tex.

Yearbook U. S. Dept. of Agriculture, 1900.

always paid out of the sum total of the nation's capacity to do work. It makes little difference ultimately whether the labor is paid for from Government funds collected by the sale of stamps or otherwise, or is done by each man directly without intervention of the United States Treasury at all; it all comes from the people anyhow.

The only question that need be asked is whether there will be more waste of time, a larger number of empty trips by the farmer, who never knows when there is mail for him, or by the postman, who always knows whether there is something to deliver; and to this there seems to be but one answer. The number of times the farmer would be going to the post town for other reasons and the times when several families would send for mail by the same messenger enter into the calculation, of course, but in general this would not change the answer. And whether the addressee may be a farmer or townsman really is of no consequence, if free delivery involves only a short trip for the postman in the city, it also involves only a short trip for the citizen, and the corresponding relation between length of trips exists for the farm delivery.

### THE OPINIONS OF FARMERS.

The views of farmers as to rural free delivery are strikingly illustrated by the reception of the opening of a new route at Attica, Ind., on May 12, 1900. (Pl. LXV, fig. 2.) It was the busiest season of the year, but a large number of farmers came in, some of them 10 to 15 miles to get farm boxes at $2.60 apiece, so as to be ready for the carrier.

Further evidence of the general favor in which the system is held by farmers is found in hundreds of letters in answer to inquiries sent out by this Department. Only one in ten had any objection to offer, and frequently the objection was that the expense would be too great. In answer to this may be offered the demonstration on theoretical grounds that the real expense is much less under the new system. And more directly convincing is the demonstration by figures in the post-office reports that the cash outlay by the Government for rural free delivery is smaller than for a less desirable service through country post office and star route. The loss of work to the farming community in going to the post office for mail is shown to be absolute and total waste.

Of the letters from farmers, a few are here presented. They are selected so as to show as fully as practicable opinions of all kinds:

*Jason Woodman, Paw Paw, Mich.:* The daily delivery at his "place of business" of the farmer's letters, market reports, and daily paper are as essential to him as such things are to any business man. In my own case it saves hundreds of miles driving and days of time each year.

*W. S. Jordan, North Manchester, Ind.:* * * * After a trial of nearly a year we feel as though it would take away part of life to give it up.

*E. D. Nauman, Thornburg, Iowa.:* * * * It will greatly assist the farmer in a material and practical way by giving him the markets and United States weather forecasts daily. Of the two, I regard the weather forecasts fully as important as the markets. Under the old system the farmers, for whom to a large extent the weather bulletins are intended, do not see them with sufficient regularity to be of much value to them. And at that season of the year when the weather forecasts are of most value to the farmer (harvest time) he is too busy to visit the post office to either see the bulletin there displayed or to get his daily paper.

*Jonathan B. Allen, Delavan, Ill.:* * * * In November I sold 3,000 bushels of corn; there was a difference of 3 cents a bushel between the highest and lowest bid of six elevators that are located within 5 miles of me. I consider a farm on rural mail route worth 5 per cent more than a farm that is not.

*W. D. H. Johnson, Holton, Ga.:* * * * I would suggest that the carrier be required to carry the weather flags on his conveyance where the Weather Bureau has a signal station, as is the case at our starting point.

*T. C. Badger, Smith Center, Kans.:* * * * Perhaps the greatest advantage is in knowing the market prices each day. The buyers here use Kansas City markets as a basis for buying, and the farmers can be, and some of them are, just as well informed as anyone. I know of two that made the price of their daily paper on one load of hogs each. It is the forerunner of other deliveries [of grocers and the like] along the route.

*W. M. Hilleary, Turner, Oreg.:* * * * We have had the benefits of free rural mail delivery at Turner for more than three years. The farmers are well pleased with its benefits and pleasures. * * * Before free delivery was started there were 13 daily papers taken at Turner post office. To-day there are 113. This shows that the farmers are getting in touch with the world and are quick to avail themselves of all educational facilities. With the general extension of rural free mail delivery there will be less talk about the monotony of farm life and less desire of the boys and girls to get away from the farm. The only objectors are small retailers of merchandise and dealers in liquors and tobacco. It may injure the business of the latter, since many farmers do not drink or smoke, only when they go to the village; and their families get the benefit in more reading matter.

*O. N. Cadwell, Carpinteria, Cal.:* * * * It brings our daily papers promptly, so that saves us time and anxiety. The weather report is dropped in our box, and that is the first thing I look at, to see what it says about the weather to-morrow.

*C. P. Waugh, Wellsburg, W. Va.:* * * * We have three routes in this county that have been in operation for 18 months and are delivering mail every day to 1,275 persons. In the 18 months the increase in the amount of mail delivered and collected amounted to a little over 57 per cent. These 1,275 people live on an average about 2 miles from the office, and before the R. F. D. started only went for their mail about twice per week, and it required about one hour each week for each person to go for his mail; 1,275 hours per week, 66,300 hours per year, or 6,630 days of 10 hours each lost every year going for mail twice per week, and then not receiving half the benefits we do at the present time.

* * * By having plenty of good and cheap reading delivered at our doors every day free of charge it not only makes the farmers and their families read more, but it makes them think more.

*J. S. Hollingsworth, Snacks, Ind.:* * * * Here is a sample of the benefits: I get two dailies every morning. * * * On November 16, 1900, I saw a big jump in potato market. Next day I left a postal card in a United States box at the crossroads for a farmer 3 miles distant to "hold your big potato crop; a jump is on the market; don't sell too soon." In two weeks from that date he sold 1,000 bushels at 20 cents above the October market.

*Matthew Williams, Verndale, Minn.:* As the whole world has been drawn closer together by the inventions and uses of steam and electricity, so farmers may be drawn closer together by the universal practice of free delivery.

*State Senator Thomas J. Lindley, Ind.:* * * * I can say with confidence that there is no other way in which the expenditure of a like sum of money brings as great good to so large a number of the people. The farmer on a rural route is in close and constant touch with the world. He no longer feels the isolation of country life. I think the system will contribute largely to prevent the threatened congestion of population in our cities and towns. I speak after two years' experience on a rural route 7 miles from town.

*Frank L. Gerrish, Boscawen, N. H.:* * * * Some of the farmers got their eyes opened on the apple crop by taking papers they had not before, and made a nice thing by holding. These routes are not all they might be, but constant improvements will do much to help these back farms and keep them in touch with the near markets.

*Postmaster Henry Robinson, Concord, N. H.:* [At the request of Mr. Gerrish, Mr. Robinson sent letters praising the new system from 32 farmers, all living along routes radiating from that office.]

* * * If this State gets a fair allotment of the Congressional appropriation for rural free mail delivery during the fiscal year beginning July 1 next, the whole State of New Hampshire will be substantially covered, especially the principal highways, by the rural carrier service. The grangers in New Hampshire have made themselves its especial champions.

* * * The local system of rural free delivery centering at the Concord post office already comprises 26 contiguous routes. These routes, on an average, include 600 people each, which, together with the people of the city of Concord, who enjoy city and rural free delivery, include substantially 35,000 people, or more than one-half of the population of Merrimack County. These routes cover substantially 1,000 miles of highways. The rural carrier service in central New Hampshire now covers a tract of territory from the city of Franklin and the town of Salisbury, the birthplace of Daniel Webster, on the north, to the village of Litchfield, on the south, a distance of 50 miles, and from Pittsfield on the east to Henniker on the west, a distance of 34 miles.

* * * The impetus to the good-roads movement is very great, and the value of real estate generally throughout the delivery territory is increased.

*G. L. Webster, Opelika, Ala.:* * * * There are three routes out from this place. The first has been in operation for four years, the other two one year, and they have all proved eminently successful. * * * The amount of mail matter carried out on this route has more than doubled since their establishment, and many farmers are taking papers and getting daily crop reports that formerly only got this information once a week.

*Z. Taylor Chrisman, Warwick, Pa.:* * * * If rural free delivery must close our local post office and give us but one delivery a day and remove the post office so far from us that we can't go to it no matter how urgent, or should we receive a letter that required an immediate answer, it could not be answered until the next day, I can't see that it will benefit us.

Could not the Department with equal economy have a carrier from each local office distribute the mail daily, and we would still have our office, so that we could send or receive any additional mail?

*John M. True, secretary State board of agriculture, Madison, Wis.:* I am of the opinion that the most sanguine expectations of the friends of rural free delivery are to be more than realized. I am informed that upon lines established in my vicinity four months since the amount of mail handled has already largely increased, showing a prompt disposition on the part of farmers to avail themselves of increased facilities for general reading, which means more intelligent ideas of business, periodicals, and social questions. It measurably removes the feeling of isolation that has been one of the great drawbacks to rural life.

The whole tendency of the system is to elevate the farmer, making him a broader, more refined, happier, and more useful citizen.

*S. C. McDowell, Fox Lake, Wis.:* * * * Rural free delivery will encourage the people to make better roads. It has already had an influence on the price of land, which has increased $5 per acre already.

*F. D. T. Hall, Lamberton, N. Y.:* * * * Farmers who have all their lives been content with one or two mails a week declare they could not go back to the old way, but if the rural free delivery were to be taken away they would combine and employ a carrier at their own expense.

*J. B. Cain, Aurora, Nebr.:* * * * Living 9 miles from the post office, only getting our mail once or twice a week, then to have a mail route so we can take a daily, is a blessing that a few years ago was not dreamed of. Other cattle feeders as well as myself have driven hundreds of miles for reports of stock market that we now get daily.

*William Schafer, Northcreek, Ohio:* * * * I don't believe it will ever be a complete success. I have watched the working of it near us in Defiance County, Ohio. [Pl. LXIV, fig. 2.] It works all right along the routes where there are good roads, but those goods roads are only a few, and I notice that the majority of citizens living at remote points have no accommodation; and again I see where parties go to town and right past the post office and could get their mail just the same. * * *

If the Government is inclined to do a good act for the mail service, let them extend the distance of special delivery. If a person in the country receives a letter of importance with a special-delivery stamp, if it is beyond the limit directed by law he doesn't get his letter.

### REPORTS OF SPECIAL AGENTS OF THE POST OFFICE.

The opinions of special agents engaged in introducing free rural delivery in all parts of the United States, as shown in their reports in 1899 and 1900, are invariably favorable to the success of the system. All agree that the opposition comes only from persons interested in the mail service who think they are likely to lose by the change, and from small storekeepers and saloon keepers at fourth-class post offices. Some of them mention also as difficulties to be overcome the fact that the work has been generally spoken of as experimental, and the impossibility of serving all persons precisely alike. The following expressions fairly represent the views of the special agents. The first two are reports for 1899, the others for 1900:

*A. B. Smith, Eastern Division:* More letters are written and received; more newspapers and magazines read; more intelligence diffused; modern methods are employed on the farm, and better crops are harvested; rural life loses its loneliness and isolation dreaded by all; lands appreciate in value; abandoned farms are again occupied; congested centers find an outlet; inducements to peculation in the postal service are diminished; the service is placed abreast of the times and in accord with the business sentiment of the age.

*Thomas Howard, St. Paul, Minn.:* The free delivery service offers a solution of the very serious sociological and economic problem presented by the tendency of young men and women residing in rural districts to gravitate toward the cities. I have noticed a distinct improvement in the habits and general moral tone of communities supplied with the service.

*F. M. Dice, Middle Division:* A great many of the localities have provided uniforms for the carriers by private donations, and have aided carriers to secure special wagons for the delivery of the mails, and are active in their efforts to obtain the best mail boxes for use on their routes.

*William E. Annin, Western Division:* In Iowa forty routes have been laid out in three Congressional districts during the last two months, all equipped with lock signal boxes erected on posts which are dressed, painted, and numbered. The influence of rural free delivery in stimulating the work for good roads has been powerful in not a few instances in securing appropriations for the bettering of roads, the building of bridges, the repair of culverts, and the maintenance of way.

Mr. A. W. Machen, Superintendent of the Free Delivery System, and Mr. H. Conquest Clarke, of the Southern Division, with general supervision at Washington of the rural service, concur in these views.

### METHOD OF PROCEDURE IN STARTING NEW ROUTES.

In order to introduce rural free delivery on a new route, a petition must be circulated and signed showing the desire of the persons along the line for the new service. This paper is then forwarded to the Representative in Congress from the district in which the route will be located, or to one of the Senators from the State, for his recommendation. If it is deemed practicable to start the service as desired, a special agent of the Post-Office Department is sent to lay out a route and make a map of it. His report and map must show that at least 100 families can be made accessible to the delivery. It also shows the character of the roads, and the agent impresses upon the persons interested that the roads must be made passable summer and winter.

A full route is considered 25 miles, but according to the country traversed may vary from 17 to 35 miles. It does not take the carrier over the same ground twice in the same day.

Carriers were paid at first only $150 a year. They now receive $500 for an ordinary route and for special short routes $100 a year for each 5 miles traveled. They are bonded, and each carrier has a bonded substitute, so that the mails may never lack a responsible carrier. The civil-service regulations have never been applied to this service, but good character and temperate habits are required. Women are acceptable, and a few are in the ranks, some of them considered very efficient. Reports to the Post-Office Department of dereliction of duty on the part of rural carriers are very few.

### SUMMARY OF ADVANTAGES AND OBJECTIONS.

Postmaster-General Charles Emory Smith in his last report summarizes the results attained as follows:

Rural delivery has now been sufficiently tried to measure its effects. The immediate and direct results are clearly apparent. It stimulates social and business correspondence, and so swells the postal receipts. Its introduction is invariably followed by a large increase in the circulation of the press and of periodical literature. The farm is thus brought into direct daily contact with the currents and movements of the business world. A more accurate knowledge of ruling markets and varying prices is diffused, and the producer, with his quicker communication and larger information, is placed on a surer footing. The value of farms, as has been shown in many cases, is enhanced. Good roads become indispensable, and their improvement is the essential condition of the service. The material and measurable benefits are signal and unmistakable.

But the movement exercises a wider and deeper influence. It becomes a factor in the social and economic tendencies of American life. The disposition to leave the farm for the town is a familiar effect of our past conditions. But this tendency is checked, and may be materially changed by an advance which conveys many of the advantages of the town to the farm. Rural free delivery brings the farm within the daily range of the intellectual and commercial activities of the world, and the isolation and monotony which have been the bane of agricultural life are sensibly mitigated. It proves to be one of the most effective and powerful of educational agencies. Wherever it is extended the schools improve and the civic spirit of the community feels a new pulsation; the standard of intelligence is raised, enlightened interest in public affairs is quickened, and better citizenship follows.

With all these results clearly indicated by the experiment as thus far tried, rural free delivery is plainly here to stay. It can not be abandoned where it has been established, and it can not be maintained without being extended.

The objections are: Fourth-class postmasters and star-route contractors are thrown out of some work, and the custom of large numbers of farmers is diverted from its former channels, a disturbance of business of indefinite proportions but of real consequence, yet soon remedied by a readjustment of relations; delay of mails of persons who have lived near enough to the country offices to send for mail early, but who are reached by the rural carrier only as he returns late in the day at the end of his route; and the impossibility of reaching very remote homesteads with rural carriers.

The balance in favor of rural free delivery is so great, the reception by farmers so enthusiastic, and the demands for its extension so widespread and urgent that the Post-Office Department now makes an estimate for it as no longer an experiment, and Congress in its liberal appropriations appears to have accepted this view, although the word "experimental" is still retained in the postal appropriation bill. The growth of the administrative work at Washington has been so great that additional room is now being provided for the force of employees.

The conditions shown justify the opinion more than once expressed by the Post-Office Department, that the United States must follow the lead of France, England, Germany, Austria, and other countries, whose closely settled lands sooner suggested it, and establish a free delivery service everywhere. It is already manifest that the service is in some respects superior to that of the older countries, and when it is fully developed and running smoothly Americans and foreigners will alike be surprised if it is not clearly superior in all its details.

# SUCCESSFUL WHEAT GROWING IN SEMIARID DISTRICTS.

By Mark Alfred Carleton,
*Cerealist, Division of Vegetable Physiology and Pathology.*

## INTRODUCTION.

There has been much discussion in recent years of the question of the future wheat supply of the world, and in some quarters fears have been expressed that by the end of the next thirty years we may experience a universal wheat famine, provided that the present rate of increase of the bread-eating population and the present yield of wheat per acre shall continue.[1] It is not the purpose to enter into this discussion here, except to say that the subject is at any rate one which deserves serious consideration, and is of interest from the standpoint of the agricultural scientist, as well as from that of the statistician. Whether such a failure in the wheat supply shall come sooner or later, there is no question as to the need of giving attention to all possible means of increasing the product of the lands that are already farmed. By this means there may be accomplished the double purpose of increasing not only the general supply of wheat, but also the profits derived by the individual farmer from a given amount of land. At present a very good opportunity of making improvements which shall be productive of immediate returns is to be found in the development of the semiarid districts.

There is no general agreement among agriculturists as to what part of the country may be properly called semiarid and what part should be considered completely arid. Ideas concerning the line that should separate the semiarid from the humid region are equally indefinite. In fact, there is possible need of a fourth term—semihumid—to designate a region lying between these last two. In this paper the term semiarid may be understood to refer, approximately, to that portion

[1] Sir William Crookes's presidential address before the British Association for the Advancement of Science, at Bristol, September 7, 1898; The World's Wheat Supply, by Sirs Lawes and Gilbert, London, 1898 (reprint of letter in London Times, December 2, 1898); Edward Atkinson, Popular Science Monthly, Vol. LIV, pp. 145–162 and 759–772, December, 1898, and April, 1899; John Hyde, North American Review, Vol. CLXVIII, pp. 191–205, February, 1899; C. D. Roper, Popular Science Monthly, Vol. LXV, pp. 766 and 777, October, 1899; The Wheat Problem, by Sir William Crookes, London, 1899.

of the Great Plains lying between the ninety-ninth and one hundred and second meridians, to portions of eastern Washington and Oregon, and to those small portions of the Rocky Mountain and basin States where crops are grown without irrigation. The conditions in these semiarid districts are at times very discouraging. They are characterized by great extremes, occasional abundant harvests and partial or entire failures following each other at intervals of two to five years. These occurrences are closely associated with corresponding periods of extremes in temperature and rainfall. Such extremes also occur often during the same season, so that the weather may in a single season be so favorable for one crop as to secure an excellent harvest, and yet be exceedingly unfavorable for some other crop. For example, in the middle States of the Plains it is seldom that large harvests of both wheat and corn are obtained in the same year. As the wheat harvests in this region are, with a good rainfall, always excellent compared with those of other districts, any improvements that would insure conditions favorable to a good average harvest in all seasons are of the greatest importance. There will soon be no more new lands to be opened to settlement that are suitable for wheat culture, consequently an increase in the average yield of such lands as these is one of the means which must be depended upon in order to increase the general supply of wheat. Moreover, it is a matter worthy of note that the wheats usually grown in semiarid districts possess a very high quality of grain. They are always hard-grained, and furnish a large amount of gluten of the best quality. The same climatic features that cause aridity—namely, extreme heat and drought—are fortunately those which also produce an excellent quality of grain when acting in conjunction with a soil rich in nitrogen.

## IS A YEARLY CROP OF WHEAT POSSIBLE IN SEMIARID DISTRICTS WITHOUT IRRIGATION?

It is only in exceedingly small portions of the wheat-growing area, especially in Utah, Idaho, and Colorado, that wheat has yet been grown by irrigation. In all other portions where irrigation is at all desirable, it is the testimony of irrigation engineers, and is at least the general belief of cultivators, that only a very small percentage of the lands can be irrigated—perhaps no more than 10 per cent at most. But even where irrigation can be carried on the cost may be so great that the additional yield obtained thereby will not justify the practice, especially if a fair average crop be produced every year in semiarid districts without it. It is the belief of the writer that this is possible, at least, over very large areas.

It may be noted by any careful observer that occasionally there are farmers in these districts who seem always to have a good crop of wheat whatever the season, even when there may be failures of the crop all about them. As other farmers in the vicinity have the same climate, and approximately the same kind of soil, such differences in results can not be due to differences in these conditions. They are simply due to certain methods of agriculture adopted by these farmers by which they are able to overcome unfavorable conditions of the weather. The Russian farmers who settled years ago in various portions of the Great Plains region have been especially successful in wheat growing in those localities. Coming originally from regions of constantly recurring droughts and cold winters, they have long ago learned how best to combat such adverse conditions. Many of these farmers, including a large number of the Mennonites, from the government of Taurida, who settled in McPherson, Harvey, Ellis, Graham, and other counties of Kansas, have always grown wheat quite extensively and with comparatively few failures. During the years 1895 and 1896, when the wheat crop was almost an entire failure in large portions of the Great Plains, these farmers continued to have good harvests. In the autumn of 1896 the writer visited a number of these farms in McPherson County, when most of the thrashing had been done and much of the wheat was being hauled to the markets. The usual average yield was 22 to 25 bushels per acre, and occasionally there were yields of 30 and 35 bushels. The grain generally overweighed, reaching often 62 pounds per bushel.

In south and east Russia fair average yields of wheat of superior quality are obtained where the climate is characterized by great extremes of heat and cold and the rainfall is considerably less than on our Great Plains near the one hundredth meridian. The larger part of the most valuable Russian macaroni wheat and much of the red-grained Russian and Ghirka spring wheats, in quality equaling our Dakota Fifes and Blue Stems, are produced east of the Volga, with an average rainfall of 15 inches or less; while the excellent hard winter wheats of the Crimea, Don territory, Kharkov, and north Caucasus endure the most rigorous winters and are grown with a rainfall and summer temperature similar to that near the one hundredth meridian, from Kansas to South Dakota.

The average yearly production of wheat in Kharkov government during the four years 1896–1899 was 11,438,850 bushels, with an average yield of 7.7 bushels per acre.[1] Almost one-fifth of this production is winter wheat, although the climate is apparently parallel with that of the Nebraska and South Dakota border. The normal rainfall at the city of Kharkov is 19.4 inches per annum, 2 inches less than at Huron, S. Dak.[2] Statistics, however, do not reveal the fact, known

[1] Calculated as accurately as possible from the reports of the central committee of statistics of the ministry of the interior of Russia for the years 1896–1899.

[2] All figures concerning rainfall are averages taken from "Die Regenverhältnisse des Russischen Reiches" (Wild), S. 12–28, Kaiserl. Akad. der Wissensch., St. Petersburg, 1881 and 1887; also "Report of the Chief of the Weather Bureau" (Harrington), 1891–92, U. S. Dept. Agr., Washington, 1893.

to the writer, that a large part of the fall-sown crop of the most excellent quality is grown east of the city of Kharkov, where the climate is much more severe, characterized especially by dry, cold winter winds. In the government of Stavropol, in north Caucasus, the average yearly production is 12,249,210 bushels, of which nearly four-fifths is winter wheat. The average yield per acre is 6.8 bushels for the years 1896–1899, including one extremely bad season. Here the temperature is milder than in Kharkov, but the rainfall is very light and particularly uncertain. In the larger part of the government, where most of the wheat is grown, no meteorological records are kept, but the rainfall probably averages under 18 inches.

On the other hand, in Kansas the average yield per acre for the part of the State lying west of the ninety-ninth meridian for the years of 1895–1899 was 6.7 bushels,[1] 1 bushel less than in Kharkov, where the climate, in both winter and summer, is much more severe.

A still better example for comparison is to be found in the wheat production of the lower Volga region of east Russia. In this region are comprised the three governments of Samara, Orenburg, and Astrakhan. The climate is characterized by the greatest extremes of heat, cold, and drought. An average of the normal yearly rainfall of six points, scattered pretty well over the entire territory, is 12.7 inches—a precipitation approaching that of regions practically arid. Yet, this is one of the principal wheat regions of Russia. The average yearly production for 1896–1899 was 44,980,050 bushels, and the average yield per acre 6.6 bushels.

For Turkestan, which in a broad sense may be considered to include Ferghana, Syr-Darya, Samarcand, and Transcaspia, no satisfactory statistics have yet been reported, but rough estimates made in the year 1892 for the report on agricultural industries of Russia, prepared for the World's Columbian Exposition, made the annual production of wheat at that time about 15,000,000 bushels, and that of all other grains about 16,000,000 bushels. The average yearly rainfall is 6 to 10 inches, or even less, and the summers are characterized by intense heat. Nevertheless, a large part of the wheat crop is grown without irrigation, though all winter wheat is irrigated. The yields per acre are not reported, but are said to be very fair, even on unwatered (bogarny) lands.

That the yield of wheat does not depend upon the absolute amount of rainfall is established by facts well known in our own country. In the Palouse region of Washington and Idaho 12 inches yearly rainfall is usually considered to be sufficient for a good crop of wheat, while in the plains States 21 inches is not supposed to be sufficient, the conditions of culture being approximately the same in the two regions.

[1] Calculated from reports of the secretary of the Kansas State board of agriculture for the years 1895–1899.

In the former region the nature of the soil makes it much better able to conserve the moisture that does fall. In that part of Oregon near The Dalles the average yield of wheat without irrigation during the last three years, according to the vice-director of the Oregon Agricultural Experiment Station, was 23 bushels per acre on summer-fallowed land. In 1900 it was 25 to 44 bushels per acre. Yet, the climatic conditions there are such as prevail in regions practically arid instead of semiarid. The rainfall at Moro, in that district, during the year November 1, 1897, to November 1, 1898, was 8.64 inches, estimating the amount for September (for which there is no record) as a mean between August and October, which, according to experience, is approximately correct.

The facts furnished by the foregoing comparisons, and many others, which lack of space precludes mentioning here, are, it seems to the writer, sufficient proof that a constant yearly crop of good average yield may be depended upon over far the larger area of the semiarid districts. The importance of such a proposition, if true, must be generally acknowledged. The question then naturally arises, how is this constant yearly crop to be secured. If we exclude such examples as those of eastern Oregon and the Palouse region, where the natural condition of the soil is unusually favorable for great conservation of moisture, it will be found that any marked increase in average yields in the semiarid districts may be secured in two ways: (1) By a proper selection of hardy varieties, and (2) by proper methods of culture.

### VARIETIES BEST FOR SEMIARID DISTRICTS.

As already stated, the conditions of soil and climate of the semiarid districts are usually such as are adapted for the growth of the glutinous, hard-grained wheats. This is a matter so important that only such varieties are to be considered, as a rule, although in districts like the Palouse region the composition of the soil is such as to permit a deterioration in the gluten content of the grain. There are three general classes of wheats from which we may select varieties that are in various degrees more resistant to the adverse conditions of these districts than those now grown and therefore able to produce larger average yields. These are (1) the red spring wheats; (2) the hardy winter wheats; (3) the macaroni wheats.

#### RED SPRING VARIETIES.

It would hardly be supposed that any varieties of red spring wheats could be obtained better fitted for cultivation in the Dakotas than the well-known Fifes and Blue Stems now grown in those States. There are seasons, however, when even these excellent varieties are seriously damaged by drought in a large portion of this region; while there are several varieties of the very best milling quality in extreme east Russia and western Siberia, which in such seasons would probably be better able to withstand the drought, as they are grown in the lower Volga region, already mentioned as a region of the severest extremes of climate. These varieties are both bearded and beardless, the best sorts, however, being bearded. Probably the best one of all is the variety called simply Russian,[1] a bearded sort, very hard, red-grained, and extremely resistant to drought. It produces fair crops under conditions as arid as those of the Ural and Turghai territories, just across the Ural River in Siberia. The next best sort of this class is the variety Spring Ghirka, so commonly grown as to have become the chief export variety of the Volga region. It is without beards and possesses a grain with a thin bran and a very large percentage of gluten of excellent quality. It is rather similar to the Fife wheats of this country. Judging from many series of analyses made of various wheats, it is probable that these varieties possess the highest gluten content known among bread wheats.

### HARDY WINTER VARIETIES.

The establishment of winter varieties is the most difficult problem in the entire work of securing wheats adapted to semiarid conditions. The difficulties in the way are double those encountered in connection with spring wheats, since the winter sorts have to withstand both drought and cold. The effect of the cold is also all the more severe because of the accompanying drought. Nevertheless, if once such varieties are successfully established and the winter-wheat area in these districts thereby widely extended, the importance of the accomplishment will probably be admitted by all wheat growers. In addition to the well-known general truth that the same variety sown in the autumn, if able to withstand the winter, will usually give a larger yield of better grain than if sown in the spring, it is also true that winter varieties are able in particular instances to overcome the effects of spring drought better than spring-sown grain, because of their great reserve force in the amount of root growth attained the previous autumn. Besides, winter sorts are often more likely to escape certain diseases on account of their earlier maturity.

To show the value of the use of these hardy varieties of the Russian type one needs only to call to mind the Crimean wheat, known under the misleading name of Turkey, which has been grown for twenty-five years or more in Kansas, and is now also grown extensively in Nebraska, Iowa, and Oklahoma, and to a lesser extent in other parts of the country. By its hardiness it has entirely revolutionized the winter-wheat industry of the middle Plains States. Fresh importations of seed from the Crimea or other parts of the government of

[1] No. 2955 of the Section of Seed and Plant Introduction of this Department.


D. G. Passmore.

A. HOEN & CO. LITHOCAUSTIC, BALTIMORE.

DROUGHT-RESISTANT WHEATS—HARD WINTER VARIETIES.

1, TURKEY (CRIMEAN); 2, ODESSA WHITE CHAFF; 3, ODESSA RED CHAFF; 4, ROUMANIAN WHITE CHAFF; 5, KHARKOV; 6, ULTA.

Taurida have been made at different times, until now the variety is universally recognized as an indispensable component of the agriculture of these States. By means of this single variety alone the winter-wheat flour of these States has risen in reputation to be a well-recognized rival in foreign markets of the output from Minneapolis and Budapest. Its cultivation has at the same time caused a very marked extension of the winter-wheat area, which was not before possible because of the severity of the winters.

Even this variety, however, occasionally succumbs to the winters in parts of Iowa and Nebraska, and fails entirely in South Dakota, Minnesota, and Wisconsin, where winter wheat ought to be and probably can be grown. It is therefore very desirable to secure varieties still hardier than the Turkey. That it is possible to do so appears now almost certain from investigations made by the writer during the past two years in east and south Russia.

The region of Russia from which, at present, the hardiest winter wheats originate includes the following governments: Southern Kherson, Taurida (including the Crimea), Ekaterinoslav, Kharkov, Don territory, Voronezh, the southern portions of Tambov and Saratov, the northern portion of Kuban territory, and the northern and eastern portions of Stavropol. The region corresponds very fairly with that portion of our Great Plains, including Kansas, eastern Colorado, Nebraska, Iowa, South Dakota, and portions of Minnesota and North Dakota. It lies in the middle of the black soil (chernozem) belt, and therefore includes the very richest lands, and has a climate marked by great extremes of temperature and severe droughts.

One of the best of the winter varieties to be obtained from this region is the Kharkov Winter wheat from the eastern part of Kharkov government, near Starobelsk. This district possesses a climate nearly or quite as severe as that of South Dakota. Summer droughts are common, and in winter the effect of the cold is much increased by the dry, piercing winds and absence of snow. This wheat is therefore probably one of the hardiest of all known winter varieties, and ought to be able to withstand the winters of South Dakota and Minnesota. It is bearded, and has a white chaff and very hard red grain. At this point it may be noted that all the most hardy winter wheats are bearded, and usually have a white chaff, though the grain is red. The Turkey or Crimean is of this kind. It is probable that all these Russian hardy winter varieties are of one common general type, but possess different degrees of hardiness depending upon the climate of the locality in which they are grown. (Pl. LXVII.)

The variety Beloglino, grown in the extreme northern portion of Stavropol, north Caucasus, is rather similar in hardiness to the Kharkov wheat, but is probably a little more drought resistant and perhaps a little less resistant to cold. It will therefore be adapted to districts considerably west of the one hundredth meridian of our Great Plains, perhaps as far as extreme western Nebraska and eastern Colorado. In 1900 this variety apparently possessed the hardest, most glutinous grain of all the Russian winter wheats. The varieties Ulta and Buivola, from central and eastern Stavropol, near the Kuma River, are also very resistant to drought and of excellent quality. There is much alkali in this district, and the rainfall diminishes rapidly toward the Caspian Sea. At a distance of 150 miles east of the city of Stavropol it is probably less than 15 inches per annum. Here there are also severe dry winds, and in the driest periods the air is filled with dust.

Several other Russian varieties and certain Roumanian sorts are also quite drought resistant, and possess a good, hard red grain, but are not so resistant to cold as those just mentioned, though some of them compare very well with the Turkey in this regard. Two of the best of these are the Odessa White Chaff and the Odessa Red Chaff, grown in the district near Odessa. The grain is very hard, apparently of excellent quality, and the yield good. The best variety of Roumania, which approaches very closely in quality of grain and resistance to drought to those of extreme southwest Russia, is the Roumanian White Chaff. All of these three varieties ought to give excellent results in Oklahoma, northern Texas, and a large part of Kansas.

### MACARONI VARIETIES.

The greatest endurance of drought is exhibited by wheats of the durum group, commonly called macaroni wheats. In eastern Russia, Turkestan, and Algeria these wheats flourish under climatic conditions so extreme as to be perhaps properly called arid, rather than semiarid. In these regions very fair crops are produced with 10 to 12 inches or less of rainfall per year. Experiments made by this Department with these varieties have already given sufficiently favorable results to show without question that they are admirably adapted to the driest portions of our Great Plains, and will probably prove successful also in Arizona, New Mexico, Utah, and the drier portions of Oregon and Washington.

In a number of instances these varieties, when grown in the same locality with the ordinary bread wheats in the States of the Great Plains, have given, in seasons of unusual drought, a yield two to four times as great as that of the ordinary wheats. In addition to drought resistance, these varieties have also the advantage of being resistant to the attacks of leaf rust and other parasitic fungi. On the other hand, they are very liable to injury in severe winters, and must be used as spring varieties north of the thirty-fifth parallel. South of that latitude they may be sown in October or November, and become practically winter wheats. By gradual adaptation through selection they may be made later to endure the winter farther north. As winter varieties they furnish abundant fall pasturage.

FIG. 1.—FIELD OF MACARONI WHEAT, NEAR THE AZOV SEA, RUSSIA.

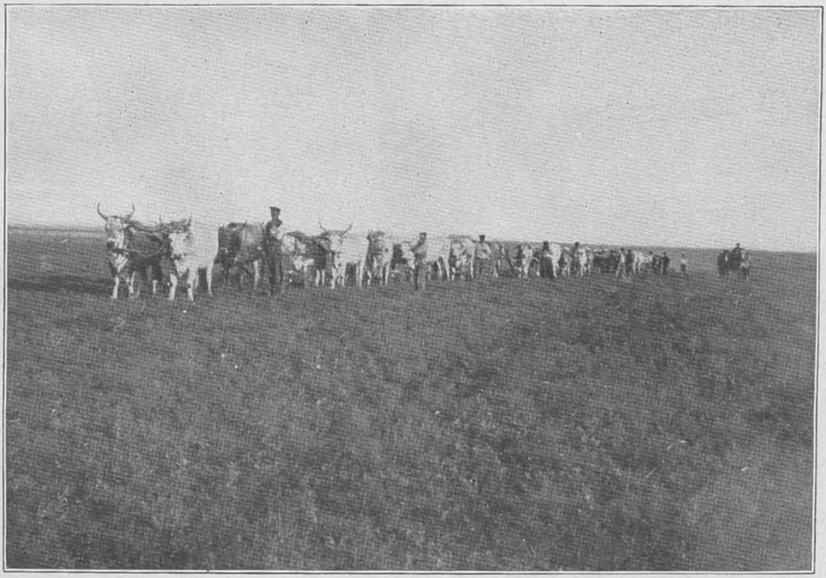


FIG. 2.—PLOWING THE "BLACK FALLOW" ON A LARGE ESTATE IN NORTHERN TAURIDA, RUSSIA.


Proctor. A. HOEN & CO. LITHOCAUSTIC, BALTIMORE.

DROUGHT-RESISTANT WHEATS'—MACARONI VARIETIES.

1, KUBANKA; 2, NICARAGUA; 3, VELVET DON; 4, BLACK DON; 5, WILD GOOSE.

Apparently the only obstacle in the way of complete success with macaroni wheats is the present uncertainty of the market—an obstacle, however, which will no doubt very soon disappear. As these wheats are employed almost solely for making macaroni and similar pastes, a market will have to be found either for export to southern France and Italy, or by stimulating sufficient demand among our own macaroni factories to establish a home market. At present our own factories make their macaroni from the common bread wheats, using, especially, flour from the Minneapolis and Kansas mills. Already some of these factories would be glad to use the true macaroni wheats if they could readily obtain the flour. As the factories do not grind their own flour, the one thing remaining is to create a sufficient interest among the flour mills to induce them to provide the proper machinery for grinding these wheats. They are so much harder than even the hardest of our bread wheats that certain changes in milling machinery are apparently needed in order to be able to grind them.

When macaroni wheat is mixed with 20 or 25 per cent of red wheat in grinding, it also makes what is considered in eastern Russia an excellent quality of flour for bread. In fact Kubanka, the chief macaroni variety, is the most popular for making bread in that region. All the mills along the Volga grind this wheat in large quantities.

The three principal varieties of macaroni wheats imported on a large scale by the factories of France and Italy are Gharnovka, or Arnautka, from the Azov Sea region, and Kubanka and Beloturka from eastern Russia. (Pl. LXVIII, fig. 1.) These are all white chaff sorts, with yellowish white grains, appearing vitreous in fracture, and are of the highest grade among macaroni varieties. A black-bearded variety with velvet chaff and dark-colored grains, and a black chaff variety are also grown in the Azov and lower Volga regions. (Pl. LXIX.) All these varieties have been introduced by the Department of Agriculture and distributed through the State experiment stations. The variety Sarui-bugda is an excellent white-chaff sort, grown mostly in Turkestan. A number of valuable varieties of macaroni wheats are also grown in Algeria, of which Medeah, Pellissier, and El Safra are among the best known. These Algerian sorts are probably best adapted in this country to districts south of the thirty-fifth parallel. Polish wheat is also sometimes used for making macaroni and other pastes. It is grown principally in south and east Russia, Turkestan, and the Mediterranean region.

In the Palouse region and similar districts, the natural conditions being rather exceptional, there is also a special demand for wheats of the club, or square-head, group, or sorts of a similar nature, which are good yielders, ripen early, do not shatter, and though drought resistant are at the same time soft wheats. Such varieties are found in Turkestan, and several of them have been introduced by the Department.

### METHODS OF CULTURE.

The selection of hardy varieties is an especially favorable means of *extending* the wheat area or the area for a certain class of wheats. To aid in making a good yearly crop within this area *constant* and *certain* it is necessary, in addition, to practice proper methods of culture. Even with an excellent variety in use, there are localities where the majority of the farmers have concluded that it is impossible to produce a paying crop each year, and that occasionally an entire failure is inevitable on account of drought or the severity of the winter. But, as already mentioned, there are often other farmers in the same localities who continue to have good harvests year after year, with the same natural conditions of climate and soil. By proper treatment of the soil these farmers have simply conserved moisture that the others have lost, and which was necessary to mature the crop. It is not simply the amount of moisture that falls, but the amount that is retained in the soil that is of chief importance. Half the average rainfall of places near the one hundredth meridian would be plenty for a crop of wheat if it could all be utilized and at the right time. In the Palouse region the soil is naturally in condition to hold much moisture. In the region of the Great Plains the farmer must aid nature by proper tillage to accomplish the same end.

#### TIME AND MANNER OF PLOWING.

The importance of very early plowing for wheat can not be too strongly urged. In recent years early plowing has apparently become more common than formerly, but it is not yet so universally practiced as it should be. If wheat is to follow wheat on the same land, the present crop should be removed at the earliest date possible, if for no other reason than to permit immediate plowing. For spring wheat, plowing should by all means be done the previous autumn or summer, however dry the ground may be. By alternate freezing and thawing during the winter the ground will be brought into good condition for further tillage the following spring. Let the first plowing be comparatively deep; afterwards all further cultivation should be near the surface, and should include discing or harrowing, or both, every four or five weeks (preferably after a rain) until seeding time. This process not only prevents evaporation, but keeps the land constantly and thoroughly clean of weeds.

Careful investigations will show that summer fallowing is in most instances unprofitable. In some portions of the country the practice is attended with much actual loss, which is apparently not fully realized. The object of summer fallowing is to conserve moisture and to give the soil an opportunity to accumulate a supply of certain available constituents by means of a year's rest, during which time the land is cultivated, but no crop is sown upon it. There is no doubt that much moisture is conserved in this way, but that purpose may be largely accomplished by early plowing, and in case of spring wheat by plowing the previous autumn. Of the solid plant foods, potash, phosphates, and nitrogen are among the most important for wheat, and are usually present in great abundance in prairie regions. In the semiarid and arid districts the greater the degree of drought the less the amount of nitrogenous food there is present in proportion to mineral salts, and hence anything that will increase the supply of nitrogenous matter becomes of chief importance. It is well known that this increase is readily accomplished by the growth of leguminous crops. In the States west of the one hundredth meridian, where there is great lack of nitrogen, leguminous cropping is especially needful. In the drier portions of the Pacific coast States summer fallowing is commonly practiced every second year. It is evident that in such cases this practice can not be regarded as immediately profitable unless the value of a crop thus obtained be equal to that of the combined crops of two years without summer fallow, deducting from the latter the expense of one year's seed, harvesting, and thrashing. It is doubtful, however, if anyone ever expects such an increase of yield by this practice. Moreover, in many instances, as observed by the writer, the fallow is allowed to become covered with weeds, which exhaust the soil as much as a cultivated crop and give no returns. On the other hand, a leguminous crop will accomplish the threefold end of (1) giving an immediate profitable return from the soil; (2) of increasing the yield of the following crop of wheat; and, (3) in extreme cases, of helping to produce a more or less permanent amelioration of the soil by neutralizing the bad effects of the presence of an excessive amount of alkali.[1]

### LESSONS FROM RUSSIAN METHODS.

Mention has been made of the success that has attended the practices of the Russian settlers in various localities of the Great Plains. These people have simply followed the methods they learned in their native country. In the southern and eastern wheat districts of Russia the people have contended with extremes of climate even more severe than ours for long periods of time. It should not be surprising, therefore, if they have learned to get the best results possible under adverse conditions. Even the peasants, crude as are their methods and ignorant as they would doubtless seem to us, have long been familiar with certain principles of agriculture not yet fully recognized in our own country.

There are many systems of crop rotation followed in the semiarid districts of Russia, some of them having been practiced for a long time.

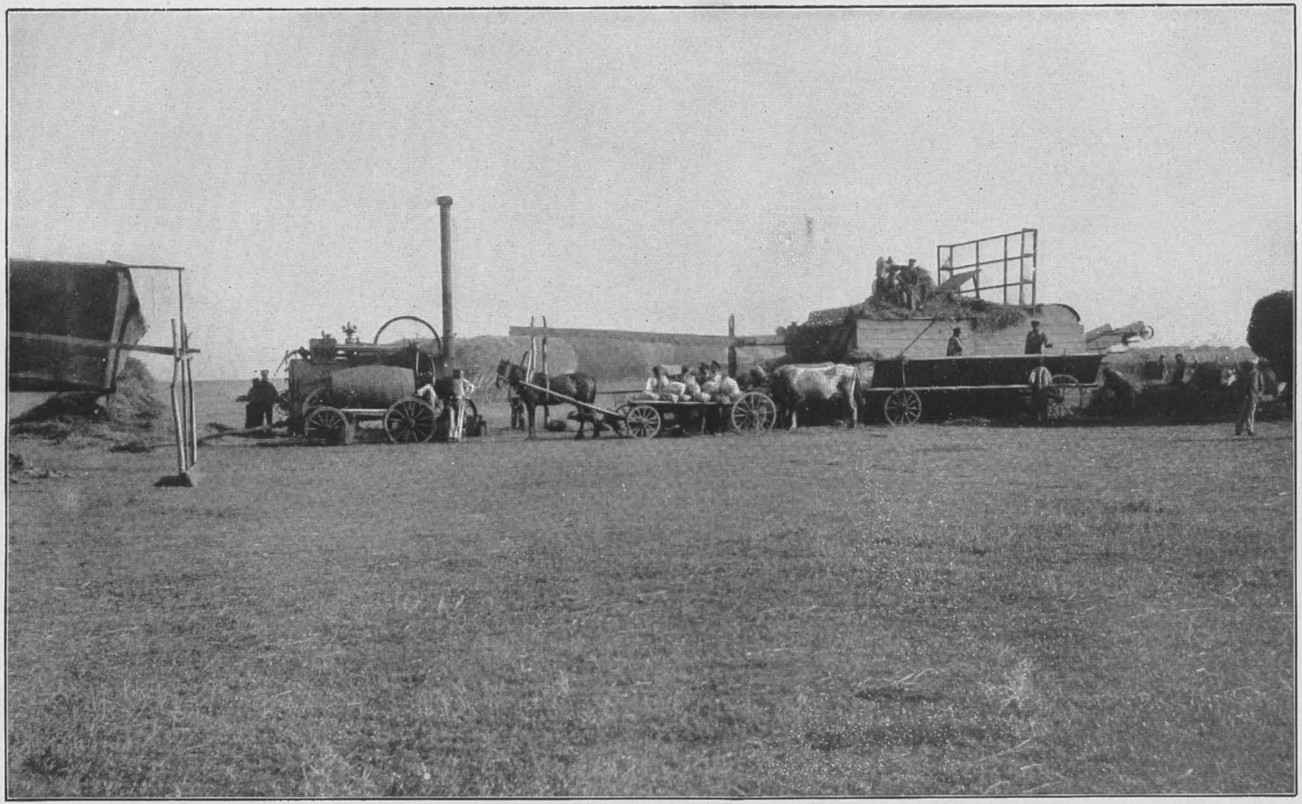
[1] See Bulletin No. 24, Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture, "The basis for the improvement of American wheats," pp. 20–25.

One system consists in planting melons as the first crop (baksha) on new ground, followed by Kubanka or Gharnovka wheat (macaroni varieties), then a hard red wheat, then a softer wheat or pasture crop. The land is then allowed to rest one or two years and a similar series of crops is afterwards repeated. There are also the three, five, and seven field systems, in which by the use of several fields it is possible to grow several different crops each year without growing the same crop twice in succession on the same field, while a period of rest can be given regularly to each field also if desired. In any system it is always the aim to grow melons or macaroni wheat on new land. Summer fallowing is practiced considerably, but by no means in all cases. On the other hand, wheat is sometimes grown several years in succession on the same land, as is too often done in this country. But whatever the system of cropping and whether summer fallowing is practiced or not, early deep plowing at first and thorough tillage thereafter until seeding time are never neglected.

### THE BLACK FALLOW.

Tillage among the peasants is usually with crude instruments. The plow (sokha) is a light machine of very primitive appearance, often drawn by one horse. After the first plowing, which is always as deep as the nature of their implements will allow, instead of using a harrow, the land is lightly cross plowed every month, or after every good rain, until seeding time. The wheat is sown by hand just before the last plowing. In some cases the seed is covered by a sort of harrow instead of the plow. On the lands of the more intelligent farmers and on all the large estates a much more modern machine is used in plowing. Large plows, rather similar to ours, are used in the first plowing, which is usually very deep, apparently considerably deeper than plowing is done in this country. The plows are usually ganged, two to one frame, and are drawn by three to five yoke of oxen. The driver never rides, and there is no provision for doing so. The subsequent tillage is performed by various machines, but usually by much lighter plows, five or six hung to a single frame, carried on three wheels, and drawn by two yoke of oxen. It is a common and interesting sight to see eight to twelve of these teams in a train plowing on the large estates. (Pl. LXVIII, fig. 2.) The writer has counted fifty plows of a dozen different patterns on one estate. In Pl. LXX is shown a modern method of thrashing, which is also commonly practiced on these large estates. At seeding time the harrow is used and the wheat is then drilled in. In these districts the fallowed land everywhere is so very dark in color that it is commonly called the "black fallow" (chernui par). The term seems not to be restricted, however, to fallow land, but is apparently often applied also to early plowing in preparation for fall or spring sowing. In the spring-wheat districts

Yearbook U. S Dept. of Agriculture, 1900.



Thrashing Wheat on the Estate of Mr. Ginter at Yoshan-lei, in Northern Taurida, Russia.

it is the universal practice, with no exceptions known to the writer, to plow early in autumn, and very deep, in preparation for the following spring crop.

### METHODS OF SEEDING.

The first thing of prime importance at seeding time is a fine seed bed. If the previous cultivation has been properly performed, however, this will be a condition easily attained. It should be kept in mind that after the first plowing the entire subsequent tillage of the seed bed is a life-and-death struggle, with possible drought, for the retention of moisture about the roots of the future wheat plant. If this fact were properly appreciated and heeded and the wheat sown early, there would seldom be a failure of the crop in semiarid districts in spite of the severest drought. Thorough cultivation should extend just a little way below the surface, while farther down the soil should be allowed to become packed, so that there may be the very least possible evaporation of moisture.

It is a pretty safe rule to follow the practice of sowing always at a date which is considered to be early in that locality. At the proper time the seeding should be done at once, without regard to weather conditions. Too many cases of partial or entire failures of crops have been the result of delay in seeding on account of waiting for rain or for some other cause. If a rain is expected the crop should by all means be in before it comes. The crop that is sown in good time comes up at once after the first rain, if not before, and is put far ahead of those sown just after a rain, much farther than would be caused by the difference in time alone. If a winter crop, it will have time to make a much stronger growth in preparation for the winter than the crops sown later, while in the case of spring wheats the early-sown crop, by ripening early, will be better able to escape certain diseases.

Of course, wheat seeding should always be done with the drill. The direction and depth of the drill rows are matters of the greatest importance in semiarid districts, particularly in seeding winter wheats. The drill rows of winter wheat should by all means run east and west, for the manifest reason that the rows will then be able to catch the snows if any fall, and the winds instead of driving the fine dirt out of the rows will rather drive it into the rows and around the plants.

We never fully realize what measure of success of the winter-wheat crop is dependent upon proper methods of drilling. The drill rows need especially to be made deep; but the form of the rows is also a matter of importance. The evolution of methods of seeding is about in the following order: (1) Sowing by hand; (2) the use of the seeder, simply a machine taking the place of the hand, with no force feed and not sowing the wheat in rows; (3) the ordinary drill with a force feed putting the grain in evenly in rows and deeper; (4) the press drill, which is probably the most perfect machine we have at present. We probably do not yet have exactly the ideal drill for winter-wheat sowing in districts of extreme drought. The proper kind of machine when made will possess a combination of features found in both the press drill and what is known as the lister drill. Each hoe of such a drill should operate somewhat similarly to a corn lister, but on a smaller scale, having a broad shovel-like construction above and a short-pointed portion below and a little behind, which would be the hoe proper. The shovels should go in about as deep as in ordinary corn cultivation and the hoe proper still $1\frac{1}{2}$ or 2 inches deeper, with a packer of some kind following behind. When so planted, the wheat is put so far down that the growing roots are surrounded with the abundant moisture of the packed portion of the soil, and the fine surface dirt falls in around the plant from above, filling up the row to such an extent that it will require a severe winter indeed to kill out the plant to the roots. In case of spring wheats on land plowed the previous autumn, by using the same method the moisture gathered during the winter will be so conserved about the roots that little more rainfall will be needed to mature a crop.

### MAINTAINING AND IMPROVING THE QUALITY OF THE WHEAT.

The practice of the best methods of culture, with varieties most resistant to drought and cold, should still be supplemented by constant selection of the best grain each year for seeding the next crop. Having once secured a variety as nearly as possible ideal for the locality, it is then necessary to maintain the standard of the variety. But it is possible to do more than that; the variety may be so improved that it will become much hardier and more prolific than the crop produced by the original seed. The Turkey wheat, even with the crudest sort of seed selection, has shown much improvement in hardiness in recent years, and is now grown much farther north than formerly. In some instances it seems also to have improved in drought resistance. If we select the hardiest varieties at present at our command and practice the most rigid selection of seed from the hardiest plants each year, a still hardier crop will soon result, which can be successfully established in a new locality with a climate still more severe, and the same process of selection can then be repeated. It is the belief of the writer that in this way the winter-wheat area may be extended northward almost indefinitely. There is an especially good opportunity for making improvements in this way in seasons of unusually severe winters, like the year 1898–99 in Nebraska, or in seasons of unusually severe drought, if one is particular in such cases to select seed from the surviving portions of the crop in fields most exposed to the weather. Spring wheats may of course be improved in a similar way with respect to drought resistance, yield, and early maturity.

# TESTING COMMERCIAL VARIETIES OF VEGETABLES.

By W. W. Tracy, Jr.,
*Assistant, Division of Botany.*

## INAUGURATION OF TESTS BY THE DEPARTMENT.

About two years ago it was determined by the Department of Agriculture to inaugurate, under the direction of the Botanist, a series of thorough tests and accurate descriptions of trade varieties of vegetables. In pursuance of this end, preliminary tests were conducted during the seasons of 1899 and 1900 at Kensington, Md., and it is proposed to continue the work on experiment grounds now occupied by the Department on the Potomac Flats within easy reach of the Department buildings. While no reports of the tests hitherto made have yet been published, it seems desirable that public attention should be called to the reasons for this undertaking and the aims and methods with which it is to be conducted.

American seedsmen catalogued last year 685 real or nominal varieties of cabbage, 320 of table beets, 340 of sweet corn, 560 of bush beans, 255 of pole beans, 320 of cucumber, 530 of lettuce, and an equally large number of varieties of other vegetables.[1] Such a long list would be sufficiently confusing, especially to gardeners and farmers, even if they all represented distinct varieties. As a matter of fact, however, many of them stand only for improved stocks of an old variety, or even merely for the particular seedsman's stock of a known variety which is neither better nor worse than other stocks. At the same time the current method of forming new names by attaching a seedsman's name or a descriptive term to an old one leaves it frequently impossible to say whether the variety is really new, or only an improved stock, or without any characteristic of novelty whatever. We have, for instance, in beans, Keeney's Rust Proof Golden Wax, Currie's Rust Proof Golden Wax, Grenell's Golden Wax, Ferry's Golden Wax, all of which are meant to be and are distinct from one another; while on the other hand we have Salzer's Golden Wax, Young's Golden Wax, Ferry's Golden Wax, Buckbee's Rust Proof Golden, Alneer's Rust Proof Golden Wax, and others which are meant to be and are names of the same variety.

[1] These figures include all names, even though they differ but slightly from others, for instance by the addition of a descriptive word. Thus, all the varieties of Golden Wax bean mentioned were counted.

A minor difficulty consists in names being duplicated unconsciously, the person giving the name not being aware that it has been given to some other sort. We have a good instance of this in the World's Fair tomato, from H. W. Buckbee, and a variety of the same name from Griffith & Turner, the former a yellow tomato of dwarf habit of growth and the latter a red tomato of large habit.[1] A source of further confusion consists in long and descriptive names, such as Improved Round-podded Extra Early Red Valentine bean and California Mammoth Solid Golden Self-blanching celery. Other names are too catchy and inappropriate to be taken seriously by the shrewd and intelligent buyer, as O! My! watermelon, and Cut and Come Again lettuce.

### INSUFFICIENCY OF THE TESTING HITHERTO CARRIED ON.

Reports of variety tests are frequently incomplete, inaccurate, and misleading. Unless carefully done, variety testing is often useless, or worse than useless, because misleading. It is stated on good authority that two differently named varieties from different seedsmen, which were reported and described by an agricultural experimenter as distinct varieties in a report of three years ago, were grown from the same stock of seed, in the same field, and by the same grower, and all harvested together. Possibly in this case the supposed difference of the two varieties may have been due to some uneven conditions of soil or culture, but it goes to show how carefully this work must be done, and how sure the experimenter should make himself of all his statements.

Variety names are often reported to be synonymous when seed of a wrong variety has been supplied or stock has been used which does not represent the generally accepted ideal of the sort. Naturally, different seedsmen and seed growers, selecting and improving their own stocks and having no standard of excellence for varieties upon which all agree, will differ as to the correct and best type of the several varieties, and thus their stocks will come to be quite different in type. A good illustration of inaccurate and misleading reports of variety tests is found in the case of Black-seeded Tennis Ball lettuce. Of this name, there have been gathered from experiment station reports and seedsmen's catalogues 34 alleged synonyms, then of these 34 names numerous alleged synonyms, then synonyms of these, until altogether 151 names were collected, which either directly or by implication are referred to Black-seeded Tennis Ball as synonyms. The unreliability of these reports is shown by the fact that the list contains such names as Tom Thumb, Perfection White Forcing, New York, Perpignan, Silver Ball, Hubbard's Market, Golden Queen, Golden Heart,

[1] It might be stated here that the Department of Agriculture is preparing this year a list of all American varieties of vegetables, which will be kept up to date by new entries every year, and later, it is expected, will be published for general distribution.

Deacon, Champion, Iceberg, Crisp as Ice, Ice Drumhead, Hanson, and Blonde Beauty, all of which well-informed seedsmen recognize to be entirely distinct from Black-seeded Tennis Ball.

With such a long list of ostensible varieties and such inaccurate and misleading statements before him, the American gardener concludes that there is but little real difference in varieties, and chooses them thereafter without much thought or study. Seedsmen, although they carry on large and expensive trials and are at present better informed on the subject of varieties and in a better position to know them than anyone else, can not attempt to test all varieties. Seedsmen conduct their variety tests for business considerations and are in no way bound to make their results public. The element of profit enters so largely into their calculations that they do not always give in their catalogues impartial descriptions of varieties. A true statement of the faults or deficiencies of a good variety might injure its sale. Some good varieties are not catalogued because they are shy seeders and the extra cost of raising the seed is too great to make their sale profitable, or the expense attached to the introduction and long-continued advertising of some peculiar and misunderstood but valuable variety is so great as to be prohibitive. The reason also for a number of our synonyms arises from the renaming of the same variety in different localities, which forces seedsmen to catalogue the varieties under these local names in order to maintain their trade in these localities.

## ADVANTAGES OF VARIETY TESTS BY THE DEPARTMENT OF AGRICULTURE.

A great deal of variety testing is done every year, but it is not performed on a sufficiently comprehensive scale. Only a small part of our long list of varieties is tested, and generally with too few plants to make a fair sample. For this reason nothing has been written which is recognized as an authority, or even occasionally appealed to. With the large resources at their command, the State experiment stations and the Department of Agriculture can, by thorough and accurate trials in different soils, climates, and conditions, and by close comparison of results, make authoritative reports and furnish reliable information regarding our American varieties of vegetables. True and standard descriptions should be made of every variety, nontypical stocks properly described, synonyms and similar varieties classified, and our present long list of varieties thus shortened and the distinctions of new varieties promptly and accurately given. With new trial grounds on the Potomac Flats at its disposal, the Department of Agriculture will this year be able to make a definite beginning in this work, commencing first with the lettuce and gradually including all vegetables. Foreign varieties of vegetables, especially new and rare kinds collected in various parts of the world by the Department agents, will also be tested and compared with our American varieties.

## OBJECTIONS TO VARIETY TESTING.

Variety testing is often said to be unprofitable because it has only local application, or it is said that the work is farfetched, or that there are not enough important differences among varieties to justify careful and expensive trials. Variety testing, however, is only local in the same sense that all kinds of horticultural operations are local. Whether variety tests made in one locality have as much application in another locality as an experiment in plant growth—for instance, a cultural experiment—would have, it is immaterial to discuss here. A little calculation will show the importance of even little differences among varieties. For example, a difference in weight of fruit of 1 ounce to a plant of tomatoes would make a difference of 2,719 ounces to the acre, or nearly 3 bushels, which early in the season when tomatoes are selling for several dollars a bushel would be a considerable item

## REQUISITES OF ADEQUATE TESTING.

To make a fair and full report of varieties and bring out all their differences, variety tests should be made in as many soils and climates and under as various conditions as possible. It is sometimes necessary to make a second test of certain classes of plants by themselves; for instance, early varieties generally require to be planted on early soil to show their real merits. Especially is this true with tomatoes, for on heavy, cold soils the early varieties sometimes show no more earliness than the later varieties. Tests of greenhouse varieties of lettuce out of doors are of little value. It is sometimes best to make separate tests in different seasons of early and late varieties, especially with cabbage and radishes. The Black-seeded Tennis Ball, Salamander, and Mammoth Black-seeded Butter varieties will in most seasons show themselves to be distinct varieties, as they unquestionably are, while in other seasons samples of the same stocks and same seed, planted in the same locality, will all look alike. The same is also true of Early Jersey Wakefield, Express, and Etampes varieties of cabbage and many other varieties of vegetables.

As large a number of plants as possible should be grown of a variety, never less than 25. Most varieties, if they show a mixture of 1 plant in 50, would be considered poor stocks; thus it can be seen upon what a close margin we have to work in variety tests to estimate the percentage of purity. With those varieties in which each fully developed plant occupies a large area very little can be done to obtain even a fairly exact percentage of purity by variety tests, for if enough individuals are reared to assure a fair average and if all the varieties of the particular vegetable are planted, an enormous space of ground would be required, which one man could not well cover. The main object of testing this class of plants would be to determine varietal differences. Then again, there are often differences in individual plants of the same variety, which make a large number of plants necessary to attain an average and fair result. There may sometimes be a greater difference between some individuals of the same variety than between some individuals of this variety and some of another, though the analysis of the results from the two varieties may prove them entirely distinct.

The soil, drainage, situation, and everything connected with the growth of the plant should, as far as possible, be uniform throughout the whole field, and likewise the work of planting, cultivating, and caring for the plants should be performed on the same days and in the same way through the whole season. A shallow drain running across the field may so influence the growth of the plants just above it as to differentiate them from those situated at a distance from the drain. Young tomato plants intended for transplanting outdoors and placed near the solid board wall of a greenhouse will grow taller and often show a marked difference through the whole season from plants that have had the full light in the greenhouse. Numerous matters of little detail must be attended to from the planting of the first seed to the taking of the last notes.

We can not expect to find such clean-cut and distinct differences among varieties as we do in distinct species of plants. The characters are less fixed and permanent and vary greatly in response to soil, climate, and the other conditions under which they grow. In some cases it requires great patience and skill to bring out all the differences. Many of our varieties, such, for instance, as those commonly classed as extra early peas, are not really varieties at all, but brands of a particular variety in the same sense in which we have brands of coffee or flour. It is not always breeding, selection, or botanical characteristics which make the difference, but simply a question of purity attained by "rogueing" or pulling out from year to year all mixtures or "off" plants, or a question of earliness or productiveness to be determined only by a mechanical measurement of these qualities.

The study of varieties is peculiar in that we have to judge of them by a number of plants, whereas in species of plants one specimen is often sufficient for a study of the species, or in buying and selling different breeds of animals, each animal is bought separately and judged by itself. But in varieties of vegetables one pea can not be planted for a whole crop, say of Stratagem peas, nor can each plant be judged individually. The seed has to be bought by the bushel and the stock judged in the field by the thousands of plants, among which there are as many chances for variation as there are individuals. It is a whole race of plants that is here bought and sold, some stocks of this pea showing a large percentage, sometimes as high as 20, of narrow-leaved plants, others a number of small, poor pods, others light-colored pods, all nevertheless being real Stratagem plants, but of a poor type and deficient in the excellencies of the sort, while in other stocks 95 per cent, or even a larger percentage of the plants, will produce only the large, dark-colored pods and broad foliage, which are the characteristics of this variety.

## DETAILS OF METHOD.

### LABELS AND NOTES.

On account of the large number of samples in a variety test it becomes necessary that a proper method of labeling and some kind of card system in taking notes be decided upon. For labels there is nothing better than white-painted wooden stakes about 2½ feet long. These labels are easily seen even when covered by foliage, are not easily broken or trampled upon, and are readily gathered up and stored for the winter. Metal labels such as are used in parks are not satisfactory on the testing ground. The samples should be numbered in regular order in the field and every sample should be represented by a card spaced off and arranged for taking notes. The card should be thick or stiff enough to be easily handled. The notes should be plain and definite in meaning. Such indefinite expressions as small, large, good, fair, poor, etc., give only the most general description, and should not be used unless their meaning is made definite by reference to known varieties or some standard of measurement. The descriptions should be carefully arranged that they may be readily understood a year later, when the two years' notes are compared. Notes also should be taken at frequent intervals during the season, as some varieties, especially varieties of cabbage and lettuce, will appear alike at one time but totally different at another.

### TERMS USED IN DESCRIPTIONS.

In describing varieties of vegetables the terms type, ideal, purity, evenness, and growth are in common use, and their meaning as here applied is different from their meaning as referring to species of plants or breeds of animals.

TYPE.—By *type*, in this connection, is meant the standard, written, or accepted character of the variety, or the conception of the variety which is thought to be correct and with which all comparisons are to be made. All the plants of a variety must be taken into consideration in forming the type, and among all the slightly or widely varying forms a relationship to the one characteristic form must be seen; in other words, the type must be the average of the plants of the variety, and the degree of perfection which is accepted as the standard must be such an one as is attainable in average good stocks of the variety. A type must be formed for every variety and firmly fixed in mind; must be retained from year to year and recognized, sometimes in spite of great changes due to the influence of different soils and other varying conditions. Photographs, drawings, or wax models will greatly assist in this endeavor.

As already stated, it sometimes happens that different seedsmen form different types of the same variety, and breed, select, and fix the variety, each according to his conception of what it should be. Among American seedsmen there are two conceptions of All the Year Round lettuce and at least three conceptions of Stone Head Golden Yellow lettuce. It must be decided in these cases which of the conceptions are to be accepted as the correct types of the two varieties.

IDEAL.—To express the different conceptions of the variety entertained by different seedsmen the term *ideal* is used, by which is meant the conception of what is evidently striven for in a particular sample. Generally the ideals of different seedsmen will agree and be the same as the true type of the variety. What difference there is among samples of the same variety is usually due to neglect in selection of stock plants, and the differences are generally not great enough to justify the classification of the samples as separate types or even ideals. They have to be regarded simply as defective types of the variety.

PURITY.—*Purity* is freedom from mixtures of other varieties, crosses, decided sports, or deviations from the type of the sample. A sample may be said to be pure when all the plants are not absolutely the same, for some allowance must be made for variation of type, as all the plants will not reproduce themselves in precisely the same mold. A certain limit for the variation of the type must be allowed. The plants which fall outside this limit are classified as impure plants.

EVENNESS.—To express the degree of uniformity among plants of the accepted type of the sample, the term *evenness* is used, meaning the closeness with which the plants belonging to the accepted type of the variety resemble one another, or vice versa. A sample may be good in purity but poor in evenness, or vice versa. For instance, among 300 plants of the Osage muskmelon there may be a great variation in the shape, size, and color of the fruits, but all this variation may fall within the limit which must be allowed for natural variation or for poor stocks of the variety, and in the lot there may be one plant which has green-fleshed instead of yellow-fleshed fruit, which, of course, is a mixture. This stock may be said to be poor in evenness but good in purity. On the other hand, if there are 50 plants which are green-fleshed or in some other way just as different from the true type of the variety, while the remaining 250 plants show great uniformity in the color, size, and shape of the fruits, the stock in this case may be said to be good in evenness but very poor in purity.

GROWTH.—*Growth* is used to express the vigor of a plant, especially as regards the number of marketable fruits. It is very important that it be noted in every case, for if a sample has done poorly such fact must be known and taken into account when it is compared with other samples.

POINTS IN THE COMPARISON OF VARIETIES.

In general, the features which demand attention in a comparison of varieties are, besides those already named, productiveness, quality, earliness, shipping and keeping qualities, selling quality or attractiveness ( pending upon good color and proper shape and size of fruits or plants), hardiness and freedom from disease, length of season of marketable fruits or plants, cost of producing the fruits or plants, cost of raising the seed, and adaptation of the variety for special purposes, such as for spring and summer growing, forcing in greenhouses or hotbeds, growing in extreme northern or southern climates, or fall planting when intended for keeping over winter and maturing next spring for an early product. Added to these, a description should be made of the variety, noting especially the peculiarities of color, form, foliage, or habit of plant which distinguish it from other varieties. The observer needs to keep these different subjects for investigation constantly in mind; for, unless an effort is made to do so, some important item is almost sure to be overlooked. To make sure of covering all these items, cards are sometimes ruled off and spaces given to each of these subjects as well as to the different botanical features of the plant and fruit. The objection to such a method is that the work is apt to become mechanical and uninteresting, discouraging individual effort and observation. A system must be decided upon between this extreme and a too independent course. Spaces may be assigned in the cards for notes on type, ideal, purity, evenness, and growth, but the dates and figures on earliness, productiveness, and length of season of marketable fruits and plants are best obtained by keeping a separate record for each of these subjects, the data for the several samples to be arranged numerically on the card or sheet, so that the characters of the varieties in these respects can be readily compared.

# THE USE AND ABUSE OF FOOD PRESERVATIVES.

By W. D. Bigelow,
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## SOME COMMON METHODS OF PRESERVING FOOD.

In hot, arid regions the question of the preservation of food is of little interest. An animal may be slain and its carcass hung in the air to dry. Other foods keep correspondingly well. Putrefaction and decay are almost unknown. On the other hand, wherever climatic conditions favor decay this question becomes important, especially for those who live at a distance from markets and who kill and preserve their own meat, and for those who, either on land or sea, are for a number of days remote from a source of supply.

The methods most commonly employed for preserving food, by drying and smoking and with salt, vinegar, alcohol, and sugar, have long been known. Some of them are probably as old as civilization itself, and indeed are not unknown to many tribes of savages. We are told by Herodotus that the ancient Egyptians were conversant with the art of preserving meat with salt, and six centuries before the Christian era Cyrus sustained his troops on long expeditions with salted meat. The aborigines of North and South America were accustomed to cure their meat by smoking or "jerking" (tearing from the bone in long strips and drying in the sun), according to the requirements of the climate. The preservation of meat by salting, drying, and smoking is practiced in Oriental countries by a number of the Mongolian tribes, including the Tartars and the Chinese. It is a matter of common information that these methods are still employed largely in civilized countries and not alone by those in rural districts who preserve their own meat. Our large packing houses smoke immense quantities of meat with hickory wood. One establishment in Chicago has 43 smokehouses, each of which holds 60,000 pounds of ham or shoulder or 120,000 pounds of side meat, besides 11 houses of half that capacity. Meat so preserved is recognized as wholesome. It is not always suitable for the sick room, but its taste is a sure indication of its character and the method of its preparation. This makes it impossible to mistake these products for fresh meat, and thus removes the great temptation to fraudulent practice that attends the use of tasteless preservatives. The preservation of meat by freezing has always been practiced, and in localities where the temperature favors this method nothing else is to be desired. Until recently, however, this method has necessarily been of limited application.

### INTRODUCTION OF CHEMICAL FOOD PRESERVATIVES AND THEIR EFFECT.

Within a quarter of a century numerous new methods for the preservation of food have been introduced, and the use of some already known has been developed. Some of these methods have been wonderfully beneficial, others are of questionable nature and value, and still others are open to the most weighty objections. The refrigerator has become a household article, the ice machine has been invented and perfected, and cold storage established in packing house, market, car, and boat; the antiseptic and toxic properties of chemicals have been studied, and the preparation and sale of chemical preservatives have become a distinct industry.

It is now a common thing for wholesale druggists, grocers, dealers in dairy supplies, and especially dealers in butchers' supplies, to advertise as a recent discovery some article of "wonderful preservative properties—but entirely wholesome."

On account of the perishable nature of many foods, it is obvious that a substance having the properties claimed for the various commercial food preservatives would be of incalculable value. At the same time it is of the utmost importance that nothing should be added to foods which is toxic in itself, or which interferes even to the slightest extent with the process of digestion. This last point is especially important in its relation to invalids and children. Food treated with antiseptic drugs may perhaps be eaten with impunity by adults who are in good health, and yet turn the scale against an infant or invalid whose life is in the balance; and, indeed, we can not say that the continued use of small amounts even of those antiseptic chemicals which seem to interfere least with the normal functions of the body will not exert a deleterious influence in time.

Again, we must remember that the absence of preservatives is often an indication of wholesome food, at least as far as cleanly methods and appliances, complete sterilization, and careful, efficient management can make it wholesome. On the other hand, the presence of chemical preservatives may often be taken as an indication that food products have been prepared by shiftless, slovenly, uncleanly, and generally inefficient methods.

Food preservatives are not used for the purpose of killing the germs that cause the decay of food. That would require an antiseptic of such a nature and in such quantity as to be distinctly dangerous to health and life. It would require such drastic measures as are employed by surgeons in disinfecting their instruments. The agents recommended by dealers for cleansing dairy utensils, when used in the quantities directed, only paralyze the germs and delay their action for a time. They can in no sense fill the office of plenty of sunshine and steam or boiling water. The use of antiseptics can no more take the place of careful, cleanly work in the preparation of foods and the cleansing of food receptacles than cheap perfumery can replace soap as a toilet article.

No tasteless food preservative has been suggested which is entirely nontoxic, and which does not have a marked influence on digestion, even when taken in relatively small doses. Some there may be whose antiseptic action is so slight that food treated with the minimum amount necessary for its preservation is not unwholesome for adults in normal health. But in any case food so treated should be plainly labeled with the name and amount of the added preservative.

### PRACTICES OF MANUFACTURERS AND DEALERS.

In using preservatives of unknown composition, reliable and well-meaning food manufacturers may unknowingly commit two wrongs: (1) They may add to their products a compound of markedly toxic properties; (2) they may violate the law. Dependence can not be placed on the claims of dealers. Representations of wholesomeness are worthless, because they accompany every food preservative. The statement that a given preservative may be used according to directions without violating the provisions of any pure-food law is always false. All claims of new discoveries and exceptional preserving power are without foundation. In this category should be placed those preservatives which by name, trade-mark, and advertising matter are represented as having the same effect on food as ice, differing only in the temperature produced.

A favorite practice is to list several compounds of widely different nature under the same or very similar names, and, while suggesting them for different classes of foods, to speak of them as identical in physiological action. The various preservatives handled by one leading firm contain, either alone or mixed with salt or salt and saltpeter in the solid state or dissolved in water, one or more of the following: Borax, boric acid, salicylic acid, salicylate of soda, benzoic acid, benzoate of soda, ammonium fluorid, formaldehyde, and sulphites. Yet, this firm advertises in such a way as to give the impression that its preparation is a definite substance with constant properties. A uniform pasteboard box is used as a container for such varieties of the preservative as may be kept in paper. This box bears a label which reads as follows:

Will keep Milk, Cream, Buttermilk, Butter, Cheese, Eggs, Meats of all kinds, Game, Poultry, Fish, Oysters, Clams, Lobster, Crabs, etc., Fruit, Vegetables, Mince

Meat, Jams, Preserves, Jellies, in prime condition, perfectly sweet and fresh for any length of time without the use of ice. * * * A superior antiseptic that prevents the spoiling of foods and retains them in their natural fresh state until consumed. Its ingredients are all as healthful as Salt. * * * Is in no sense an adulterant, and can not be used as such. It is a thoroughly harmless yet absolutely effective antiseptic for the preservation of all perishable food substances.

Notwithstanding the fact that the different kinds of preservatives consist of chemicals (often mixtures of two or more) of the most diverse toxic properties, and although these chemicals are all well known to the scientific world and many of them are familiar to the general public, yet the firm claims that its preservative is a single compound, a "perfect chemical combination" of unusual properties, and not susceptible of imitation. The following, quoted from the advertising matter, may illustrate the absurdity of the claims:

* * * The invention of an eminent German chemist and the result of many years study and research. It is a perfect chemical combination, and through this it produces its wonderful success. The invention was considered of such great importance by the government that, besides awarding the inventor more than thirty medals and prizes, the Emperor of Germany conferred upon him a special Gold Medal of Distinction. The German Government went further; for it not only adopted * * * for use in its army and navy, but it granted the Imperial Patent to the discoverer of * * * ; it endorsed its general use in the following strong language: "We do not only highly recommend to Dairymen, Farmers, Fish, Pork, and Meat Packers, as also many other technical industries, the adoption of * * * , but to our Army and Navy, as in time of war it will be of incalculable benefit in provisioning our ships and forts with fresh meats and other food substances."

Several dealers find it advantageous to sell one mixture or compound under several names. Six samples of a preservative, designated by numbers 1 to 6, inclusive, were purchased. These samples were put up in cans bearing a uniform label, on which the number was inserted with a pen. The six samples are sold at different prices and recommended for the preservation of different foods, but their composition is identical.

## NEED OF RESTRICTIVE LEGISLATION.

The States that use large amounts of commercial fertilizers have found it necessary to enact laws requiring that fertilizers be sold only in bags on which the composition of the contents is marked. Such legislation has been found equally advantageous to consumers and to reliable manufacturers, and has changed a business in which honesty once seemed impossible into one in which misrepresentation and deceit are relatively rare. Such laws work no hardship to anyone. They encourage trade and restrict fraud. They receive practically the unanimous support of all reputable citizens who have opportunity to observe their working.

It would seem that similar legislation regarding food preservatives would not be untimely. This would not sanction the miscellaneous use of preservatives, but would restrict abuses. The air of mystery with which many dealers attempt to surround their wares would thus be dispelled, and preservatives could not be sold, as they sometimes are now, for from twice to thirty times their value.

### COMPOSITION OF COMMERCIAL FOOD PRESERVATIVES.

With a view to determining the nature of substances most commonly used for the preservation of food, the writer has recently collected and examined as many as practicable of the more common commercial food preservatives. The collection of samples of this nature is attended with many difficulties, for dealers who advertise their wares as "free from salicylic acid, boric acid, sulphites, formaldehyde, and other poisonous ingredients," and "manufactured in accordance with all pure-food laws," are often anxious to keep their products out of the reach of the chemist. The composition of these samples, and also of various commercial preservatives examined in other laboratories, is given in the Appendix to this Yearbook. Of the 67 samples examined, 33 contained borax or boric acid; 10 sodium, potassium, or calcium sulphite; 8, salicylic acid or its sodium compound; 7, benzoic acid or its sodium compound; 1, boric acid and salicylic acid; 1 boric acid and ammonium fluorid; 3, formaldehyde; 1, ammonium fluorid; 2, pyroligneous acid; and 1, beta-naphthol. These substances may be divided into two classes, those which are undoubtedly injurious, such as formaldehyde, salicylic acid, and sulphites, and those whose toxic action is disputed, like borax and benzoic acid. The addition to foods of substances belonging to the first class should be proscribed. The others should be used only with food which is so marked as to inform the purchaser of their presence.

The efficiency of commercial food preservatives being due to the presence of one or more of a few very familiar chemicals or drugs, these latter will now be briefly considered.

### BORAX AND BORIC ACID.

The antiseptic property of boric acid was noted in 1856 by Jacquez, who preserved the carcasses of rabbits by immersing them in a 5 per cent aqueous solution and by injection with a 5 per cent solution. Its use as a food preservative did not become general till about 1880, since which time it has steadily increased. Both boric acid and borax are now extensively employed for the preservation of meat, fish, and dairy products.

According to the directions of dealers in food preservatives, meat that is ready for smoking may be dipped for a few minutes in a solution of 1 pound of boric acid to about 4 gallons of water; chopped meat and sausage are to receive an addition of from 1 to 4 ounces of boric acid to each 100 pounds of meat; brines used in curing meat may be treated with about 1 pound of boric acid to each 30 gallons of water, while to each 15 gallons of milk and each 30 pounds of butter may be added about an ounce of boric acid. A portion of the boric acid is often replaced with about one and one-half times its weight of borax, and occasionally the latter is used alone.

While boric acid and borax are not as objectionable as some other preservatives, yet they are toxic compounds, and there are still doubts as to whether their use should be permitted. In any case only the minimum quantity should be used, and the sale of foods containing them should not be permitted unless so labeled as to indicate their presence and the amount employed.

The medicinal dose of borax and boric acid is from 30 to 40 grains of the former and from 5 to 15 grains of the latter for an adult. A pound of meat treated according to directions with a boric-acid preservative will contain from 5 to 19 grains, while an infant who is fed each day a quart of milk so treated will receive 8 grains, or a fair-sized dose for an adult.

Borax is used in the ordinary crystallized form with 10 molecules of water, in the rhombohedral form with 5 molecules of water, and as "burned borax." Both the hydrated and the anhydrous boric acids are employed.

### SULPHITES.

In the preparation of casks for storing wine it has long been customary to treat them with a small amount of burning sulphur. The sulphurous acid so formed assists in sterilizing the casks and preventing the after fermentation of the wine. Attempts have repeatedly been made to replace sulphurous acid in controlling fermentation with other preservatives, such as salicylic and boric acids, abrastol, and formaldehyde, but all have resulted unsuccessfully. In all wine-producing countries except America the amount of sulphurous acid so employed is limited by law to one or two parts in 10,000 parts of wine (0.1 or 0.2 gram per liter, or from 1.5 to 3 grains per quart). In this connection it must be remembered that the sulphurous acid content of the wine is largely combined as aldehyde sulphurous acid. Free and sulphite sulphurous acid are only permitted in European wines in one-tenth the amount given above. The compound is recognized as distinctly toxic, and a larger proportion than that mentioned is universally recognized as injurious. The sale of beer containing sulphurous acid or sulphite (a sulphurous acid compound of a metal such as sodium or calcium) is specifically prohibited in almost all civilized countries.

By following the directions of dealers in food preservatives, we would add from 1 to 4 ounces of sodium sulphite, or its equivalent, to 100 pounds of meat, or the same amount to from 35 to 50 gallons of cider, beer, or other liquid.

The maximum amount given is certainly unreasonably large, and considering the fact that sulphites are no more efficacious than less deleterious preservatives, it would seem entirely proper that their addition to foods should be prohibited.

The medicinal dose of crystallized sodium sulphite is from 10 to 60 grains, and that of sodium bisulphite half as much. This is equivalent to from 2½ to 15 grains of combined sulphurous acid. A pound of meat, treated according to the directions mentioned above, will contain from 2½ to 10 grains of sulphurous acid, while a quart of cider, beer, etc., similarly treated will contain from 1 to 7 grains.

The preservatives of this class are not as numerous as those containing boric acid. They are much too common, however, and are often advertised as possessing such unheard-of properties that their promoters are relieved of all suspicion of ingenuousness.

### SALICYLIC ACID.

In 1874 H. Kolbe was led, by the readiness with which salicylic acid is converted into carbolic acid, to investigate the antiseptic properties of the former. He found that it prevented the fermentation of amygdalin and sugar and the putrefaction of meat and eggs. He also suggested that South American meat be packed in tight receptacles, covered with salicylic acid, and shipped to Europe.

The perfection of Kolbe's method of manufacturing salicylic acid in 1874 greatly cheapened the product and led to vigorous efforts to extend its use. During the first three or four years immediately following the discovery of its antiseptic properties, and before its physiological action was at all understood, a number of prominent chemists warmly advocated it as a food preservative. It gained in favor at first, and its use increased rapidly until 1880. In that year it was claimed by the industries interested that 110,000 pounds were used in France for the preservation of foods.

Since 1880 the mass of the evidence resulting from physiological studies with salicylic acid tends to condemn the addition of this substance to foods under all circumstances. It is possible that the majority of persons in sound health may suffer no evident injury from small amounts of salicylic acid, but its use by aged and infirm persons is attended with great danger. Many European countries prohibit the addition of salicylic acid to foods. In this country it is rapidly losing favor, and is used much less, relatively to other food preservatives, than it was five years ago. At the present time salicylic acid is chiefly used to preserve fruit and vegetable products. In following the directions of dealers in food preservatives, an ounce of salicylic acid or sodium salicylate is added to from 400 to 600 pounds (50 to 75 gallons) of liquids, and from two to three times that amount to pasty or semi-solid substances. Salicylic acid has no advantage over other preservatives which are less deleterious, to say the least, and its addition to foods would seem to be unwarranted. The medicinal dose of both salicylic acid and sodium salicylate is from 10 to 30 grains for an adult.

Owing to the early exploitation of salicylic acid as a food preservative, and the well-known indifference which characterizes both legislative bodies and the general public regarding the wholesomeness of foods, the use of salicylic acid became so common at one time that many board of health chemists still test for no other preservative. The increased attention that this matter has recently received has resulted in a decreased use of salicylic acid, relatively speaking, and some dealers in food preservatives make a practice of changing the name of a product as soon as its composition becomes generally known.

### BENZOIC ACID.

The antiseptic properties of benzoic acid were investigated by Salkowski in 1875, and this substance was early suggested as a food preservative. Its use for this purpose was sufficiently widespread in 1880 to warrant the publication of methods for its detection. During the last ten years the use of benzoic acid for the preservation of food has been rapidly increasing. This is largely due to the fact that many food manufacturers have replaced the salicylic acid they formerly employed with benzoic acid. It is usually added to wine, beer, cider, and fruit and vegetable preparations, sometimes to canned soup, and more rarely to dairy products.

According to the directions of dealers in commercial preservatives, cider, wine, and similar liquids may receive an addition of an ounce of benzoic acid or sodium benzoate to from 15 to 30 gallons, and some direct that half that quantity be added again if the liquid be racked off in the spring. This quantity, however, seems to be excessive. A firm whose methods necessitate the use of so much of an antiseptic substance should have nothing to do with the preparation of foods. It is customary to add from two to two and one-half times as much to pasty or semisolid food products as to liquids.

Benzoic acid is not as objectionable as are some compounds used as food preservatives, but there is still doubt as to its wholesomeness, and in any case the sale of food containing it and not so labeled as to inform the purchaser of that fact should be prohibited.

The dose of benzoic acid for adults is from 10 to 40 grains, and that of sodium benzoate from 10 to 60 grains. A quart of cider treated with the maximum amount mentioned above would contain 12 grains of benzoic acid.

### FORMALDEHYDE.

Formaldehyde has been used as a disinfectant and germicide for a number of years, and has also been suggested for use in surgical operations, but owing to its irritating character it has not filled the office that was expected in that field. Its use as a food preservative dates back to about 1895. It is now extensively employed for the preservation of milk, and has been reported in other articles of food. The addition of formaldehyde to foods is undoubtedly objectionable, and should be prohibited. Not only does it interfere with digestion to a marked extent, but it has been definitely proved that a compound is formed with the casein of milk which causes the latter, when treated with dilute acid such as exists in the gastric juice, to separate in hard lumps that are attacked only with difficulty by digestive ferments.

The addition of formaldehyde to milk has become only too common, and considering the fact that other and less objectionable preservatives will accomplish the same object, its use should be condemned in unqualified terms.

### FLUORIDS.

Within the last ten years the fluorids, silico-fluorids, and borofluorids have come into use to a somewhat limited extent as food preservatives. It was at first believed by many that these compounds were without deleterious effect on the human organism. It is now well known, however, that they possess a marked toxic action, and should under no circumstances be added to foods. The writer has no information concerning the use of silico-fluorids in this country as food preservatives, but they are said to be used to some extent abroad. The medicinal dose of ammonium fluorid for adults is from 0.003 to 0.065 grams (0.04 to 1 grain). But one of the samples purchased consisted of ammonium fluorid. A quart of beer treated as directed in the circular accompanying the package would contain 0.28 grains of ammonium fluorid, or seven times the minimum dose.

### BETA-NAPHTHOL.

Beta-naphthol has been suggested as a food preservative, and it has been used for that purpose to a very limited extent for at least twelve years. It is a compound of marked toxic properties. The dose for an adult is from 0.2 to 0.52 grams (3 to 8 grains), and the statement is added in Merck's Index that it must be administered with caution. Its use as a food preservative would therefore seem to be unwarranted.

### PYROLIGNEOUS ACID.

The preserving effect of smoke is recognized to be due to creosote. During the early part of the nineteenth century various newspapers called attention to the possibility of avoiding the somewhat tedious process of smoking meat by immersing it for a moment in pyroligneous acid and allowing it to dry. Several experiments on this subject were made by William Ramsay, and the results were recorded in an article published in 1820.

In recent years a great deal of pyroligneous acid has been sold under such names as "Extract of smoke" and "Liquid smoke." The use of this substance has not been studied from a hygienic standpoint, and we can only say that meat preserved with it should not be sold as smoked meat. "Liquid smoke" sells for 75 cents a quart. The same article can be bought as pyroligneous acid for 30 cents a gallon.

# THE INFLUENCE OF REFRIGERATION ON THE FRUIT INDUSTRY.

By William A. Taylor,
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## INTRODUCTION.

The rapid development of commercial fruit culture has been one of the remarkable features of the agricultural progress of the world in the century just closed. From the position of an insignificant industry at the beginning of the century it has risen to commanding importance in many countries, and in some has become the dominant feature of agriculture. Outside of the wine-producing regions of the Old World there was comparatively little commercial fruit culture a hundred years ago except in specially favored localities and for the supply of local needs. In a few localities there was a considerable production of fruit for sun drying, as in the prune districts of France and the raisin districts of Spain and other Mediterranean countries. Oranges and lemons were marketed to some extent from Sicily and Spain in the ports of western Europe, and occasional small lots found their way across the Atlantic to the seaboard cities of America, but without sufficient regularity to develop more than a speculative and haphazard trade in fruits. It seems hardly possible that no longer ago than 1871 there were but a half-dozen fruiterers in London, now the greatest fruit market in the world, and that oranges and lemons at that time constituted almost their sole stock in trade, aside from home-grown fruits in their season. Yet, this is asserted by one of the veteran dealers of the city to have been the case when he began business in that year.[1]

## INFLUENCE OF IMPROVED TRANSPORTATION.

Soil and climatic conditions were the same then as now, and the regions in the Old World to which the more important fruits were adapted were fairly well defined; choice varieties had been developed also, including many of those that are now the leaders in our markets. The one thing lacking was rapid and regular transportation. As steam was applied to navigation and to railroading during the second third of the century, orchards and vineyards expanded. Under the influence of improved shipping facilities on both sea and land, the

[1] George Monro, before Royal Horticultural Society of England, October 24, 1899.

market broadened rapidly and the fruit trade gradually took on definite form, and was recognized as a legitimate branch of commerce.

As railroads penetrated the interior of North America and Australia, new and fertile regions, blessed with a genial climate, became accessible, and the areas devoted to fruit culture rapidly increased. The story of its development in California, after American occupation, is too familiar to need repetition, and is perhaps the most conspicuous example of the rapid development of a horticultural industry in the history of the world.

This activity, though more noticeable in the newer continents, was by no means confined to them, marked development of orchard interests having occurred during the same period in England, and in France, Spain, Italy, and other Mediterranean countries. More recently this development extended to Tasmania, New Zealand, and South Africa.

The stimulus to planting afforded by the improved facilities for transportation, however, soon resulted in disastrous overproduction in some sections. Large orchards, vineyards, and small-fruit plantations were planted farther from their prospective markets than their products could be transported. This was notably true in the Southern United States, where the added incentive of high prices for early fruits in markets farther north caused large plantings of the more perishable fruits, such as strawberries, blackberries, raspberries, peaches, and plums. The planters demonstrated that they could produce these fruits in large quantity and of high quality at a relatively low cost, but the product could not, with the then existing facilities, be delivered to the distant consumer, for whom it was intended, in sound and wholesome condition. Thus, the truckers near Norfolk, Va., demonstrated as early as 1860 that the strawberry could be grown in large quantities and ripened long in advance of the Northern crop. But, as repeated shipments spoiled in transit, its culture was abandoned until the development of more durable varieties and improved transportation brought the New York market within reach of the growers. The early peach industry of South Carolina and Georgia suffered a similar experience about 1850–1870, and practically ceased to exist for a period of fifteen to twenty years; then suddenly, with the origination of a variety (Elberta) better adapted to long shipment, and the development of a car service adequate for fruit transportation, that region sprang into a leading place among the peach-producing sections of the country.

The losses to Northern growers from overproduction were also excessive. In favorable seasons the local markets often failed to take at a fair price more than a small portion of the crop, and as it was short lived at best, the prospective profits of the grower vanished through low prices during the period of ten days or two weeks in which his crop was handled. Earlier and later in the season the supply was short and the price remunerative, but neither the grower nor the dealer had fruit to sell. It was a condition of "feast or famine," with but little opportunity for profit to the average producer in either case. Though more marked in the case of the summer fruits, the same condition was true at times with the apple, which has ever been, and promises to continue to be, the most largely grown and most popular of fruits in the temperate zones. In summer and autumn the fruit lay rotting upon the ground for lack of demand at prices that would even reimburse the owner for the expense of harvesting. By midwinter the dwellers in cities and towns were unable to secure fruit at prices within the reach of average incomes. The abundance returned to the earth from whence it came, leaving the consumer hungry and the producer poorer than before.

The development of the processes of canning and evaporating did much to reduce the losses in some regions, but neither process was found sufficient to insure a fair profit to the growers of most fruits. Neither of these methods stimulates the consumption of fruit among the masses as does the display of fruit in market in its fresh state.

The desire to extend the marketing season in the vicinity of cities and the necessity, in case of producing regions remote from market, of finding outlets for the products led to the development of what is now becoming one of the most important features of the fruit industry. This is true of many portions of the United States and Canada, as well as of the rapidly developing fruit regions of Australia, Tasmania, New Zealand, and South Africa. Refrigeration in its various forms, both for warehouse storage and in transit, must now be regarded as one of the essentials in many branches of the fruit trade.

## DEVELOPMENT OF REFRIGERATION.

Records of early efforts at practical refrigeration are exceedingly fragmentary. Ice and snow were preserved by various methods, such, for instance, as storing in pits protected from the sun, practiced by the early Greeks and Romans. These substances seem to have been valued chiefly for use in the preparation of cooling drinks and foods, however, rather than for retarding the decay of perishable products. Gradually and for similar purposes freezing mixtures of ice or snow in combination with salt, saltpeter, or other chemical agents came into use in a small way. The use of these is said to have been known in Europe as early as 1607, while Fahrenheit used the ice and salt mixture in 1762 in fixing the scale for the thermometer which bears his name. Little practical use of these mixtures appears to have been made, however, until a much later date.

Ice stored in caves or cellars was utilized to some extent to retard the decay of food products, and, in seaboard localities in the North, trade in ice with the warmer portions of our country and the West

Indies developed at an early day. In 1799 a gentleman from Charleston, S. C., chartered a vessel to convey thence a cargo of ice cut from a pond in the city of New York, and in 1805 the brig *Favorite* took a cargo of 130 tons for Frederic Tudor from Boston to the island of Martinique, where it was intended for use during a yellow-fever epidemic. The shipment resulted in total loss, costing the owner $4,500. A similar shipment to Havana in 1810 also proved unprofitable. After the war of 1812 Mr. Tudor renewed his efforts, and having secured a monopoly of the ice trade of Havana, he realized profits that led him to extend his trade to the south Atlantic and Gulf ports of the United States in succeeding years, and later to the more important tropical seaports of South America and Asia. By 1834 American ice was shipped to the West Indies, Rio Janeiro, Ceylon, Calcutta, Bombay, Madras, Batavia, Manila, Singapore, Mauritius, and Australia. This trade continued to increase until about 1880, when a short ice crop in New England, in conjunction with the development of practical ice machines, gave an impetus to the production of artificial ice in the Tropics, which proved the death blow to the importation of ice into those regions.

Storage in iced chambers of various designs developed gradually, and the process was fairly successful with many products. Failures were frequent, however, through inability of operators to control the temperature and humidity of the chambers. In 1856 Rev. Benjamin M. Nyce, "preacher, teacher, and chemist," of Decatur County, Ind., began experimental work along the line of controlling these factors, and by careful construction and thorough insulation of buildings developed an ice storage house which is reported to have been very successful. This he patented November 2, 1858. In this house ice was stored upon a floor of sheet iron, which formed the ceiling of the chamber to be chilled. The water resulting from the melting of the ice was carried off through pipes discharging through suitable traps. Surplus moisture was removed from the air by absorption by chloride of calcium, "salt bitterns," which was exposed on broad trays and "renewed" from time to time by being removed and heated to evaporate the water. A ventilating fan, operated by a windmill was a feature of the original plan, but later this was considered unnecessary and was abandoned.

One of the first houses built was insulated with tarred paper, which excluded the air satisfactorily. The fumes from the paper contaminated the stored products, however, and rendered them valueless. Another, constructed largely of sheet iron, was filled with miscellaneous produce, such as butter, eggs, onions, and apples in the same compartment. The contents, though well preserved in form, were tainted in flavor and were worthless when removed. Later structures appear to have been quite successful, especially in the storage of winter apples.

Professor Nyce states that in his Cleveland storage house the temperature, as measured by three thermometers in different portions of the cold chamber, did not rise above 34° F. from April to August, 1865.[1] His theory was that an atmosphere of carbonic-acid gas retarded decay by preventing oxidation of the fruit tissue. He therefore abandoned ventilation, and endeavored to accumulate an atmosphere of carbonic-acid gas from the exhalations of the fruit. In this particular his plan was at radical variance from the advanced practice of the present, which favors thorough ventilation even at low temperatures.

Large profits resulted from the rise in value of fruit held in these houses until late winter or spring. A house built at Covington, Ky., is said to have yielded a profit of $16,000 on apples sold in May and June, 1866, while Professor Nyce, in 1870–71, stated that 4,000 bushels of apples kept in his Cleveland storage house yielded him a profit of $7,200. They had been bought at an average price of 60 cents per bushel in the fall and were sold for $2.40 per bushel in the spring. Publication of these instances of profit was followed by an active demand for the right to construct houses under the patent in different cities, and prices almost fabulous were offered in some instances. Thus, $100,000[2] was offered and declined for the right to use the process in New York City, and $250,000 was reported to have been offered for the right for the State of Louisiana. The inventor chose in the former case to operate under his own patents, however, and met financial loss.

One distinct improvement was made in New York, where, about 1865, Messrs. A. & M. Robbins, of Fulton Market, at the suggestion of Mr. W. P. Whitson,[3] an employee of the firm, utilized a freezing mixture of ice and salt stored in V-shaped galvanized iron tanks suspended from the ceiling. These were so arranged that they could be fed from above without entering the room. The walls of the room were constructed in similar manner. By this method they were able to maintain a temperature low enough to freeze large quantities of poultry and game and to hold it until needed, a result impossible of accomplishment with ice alone. This appears to have been the nearest approach to the modern cold-storage establishment prior to the introduction of mechanical refrigeration. The secret was carefully guarded for some time, but when once discovered was utilized in other cities, with the result that the marketable period of many perishable food products was materially extended.

Apples and late pears were successfully and profitably held in these various ice houses, but the summer fruits, if carried for longer than a

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[1] Ice and Refrigeration, Vol. IX (1895), p. 23.

[2] Statement of Thomas L. Rankin, in Ice and Refrigeration, June, 1894, p. 405.

[3] Letter of February 1, 1901, from A. & M. Robbins.

few days, lost flavor, and decayed. A house erected at Middletown, Del., in 1875, was arranged for cooling a storage chamber by blowing air by steam power over masses of ice, to chill it. The air was then conducted through flues to the fruit room, which was filled with peaches in baskets. The experiment was conducted with 25,000 baskets of ripe fruit, and resulted in total loss. The fruit retained its handsome appearance, but lost its natural flavor, and was impregnated with the flavor of the yellow-pine lumber with which the room was lined. The experiment was not repeated.[1]

At the present time ice storage has been practically abandoned except on farms and in small towns. In the larger establishments its place has been taken by mechanical refrigeration.

### DEVELOPMENT OF MECHANICAL REFRIGERATION.

The reduction of temperature by mechanical devices for the purposes of making ice or cooling storage chambers is much more modern than the methods of refrigeration previously described. A machine for producing cold by evaporating water in a vacuum is said to have been made in Scotland by Dr. Cullen in 1755. Lavoisier experimented with ether in France, and in 1810 Leslie experimented in Scotland with a machine using sulphuric acid and water.

In 1824 Vallance patented in England a refrigerating machine in which dry air was circulated over shallow trays of water. The rapid evaporation that resulted cooled the surrounding objects, including the water, and formed therein sheets of ice. In 1834 Hazen used the volatile spirit of caoutchouc in a refrigerating machine in England. In the same year Jacob Perkins, of London, constructed an ether machine, which, though not commercially successful, was the forerunner of the compression machines of the present day.

In 1845 Dr. John Gorrie, at New Orleans, prepared the way for the invention of the cold-air machine, through the agency of which meat was first successfully shipped from Australia to Europe. In 1850 Carré, in France, invented the ammonia absorption process, under which, at the Paris Exposition of 1867, he daily made 6 tons of ice, and which in modified forms is in use at the present time.

By that time experimenters were at work in many parts of the world, and new machines appeared at short intervals in many countries. Thus, Professor Twining is said to have had an ether machine at work in Cleveland, Ohio, about 1855, and in 1859 Harrison, who had been experimenting with ether in Victoria, Australia, placed a machine on the market. The latter appears to have been the first machine successfully applied to a manufacturing process, as it was used in England in 1861 in the extraction of paraffin from shale oil.

About this time Mr. Augustus Morris, a wealthy Australian, directed

[1] Letter from I. N. Mills, Clayton, Del., January, 1901.

public attention to the importance of perfecting methods by which fresh meat, of which there was an abundance in Australia, could be transported to England in sound condition. He had been much impressed by published accounts of frozen animals discovered in Siberia, the flesh of which had been preserved in sound condition for ages, and conceived the idea that Australian beef could be frozen and transported safely across the torrid zone to British markets. He accordingly offered to contribute £1,000 toward experiments in that direction, and interested a friend, Mr. T. S. Mort, of Sydney, in the plan. Mr. Mort took up the matter with energy and thoroughness, and in connection with Mr. E. D. Nicolle conducted elaborate experiments with different processes that were considered promising. He spent on these experiments upward of $1,000,000 before success was attained. In 1880 one lot of 400 carcasses of Australian mutton was landed in London in sound condition, and the question of markets for Australian fresh meats and similar products was solved in principle, only the details remaining to be worked out.

In 1867 T. T. S. Lowe patented a machine using liquefied carbonic acid as the refrigerating agent, and in 1869 Tellier, in France, took out a patent for the use of methylic ether. In 1877 Pictet patented liquefied sulphurous dioxide.

In 1875 Prof. Carl Linde, of the University of Munich, introduced the first ammonia-compression machine, which in various modifications now constitutes one of the leading systems.

### PRINCIPLES OF MECHANICAL REFRIGERATION.

In principle, mechanical refrigeration is simple. To cool a substance to a definite temperature and hold it there, it is necessary to absorb from it the surplus heat which it contains and then to protect it against the absorption of additional heat from outside sources. As the expansion of all substances, whether in solid, liquid, or gaseous form, is accompanied by the absorption of heat, it is only necessary that some material in the act of expanding shall be in proximity to the object to be chilled. Many different materials have been tried at different times for this purpose. Several are still in practical use, but for the refrigeration of large chambers those most generally adopted at present are certain gases, particularly anhydrous ammonia and carbon anhydride. These are capable of being greatly reduced in volume by compression by steam power into cylinders, even to liquid form, and can then be safely shipped long distances to the points where they are needed. When admitted to pipes in the building to be refrigerated these gases expand and withdraw heat from the air of the surrounding chambers and from the articles stored therein. After traversing a system of pipes the gas is relieved of its heat by being compressed in a steam pump and passed through a condenser of pipe over which cool water flows. The water, in fact, carries off the heat which the gas has absorbed from the materials in storage, while the gas, reduced to its liquid form, is available for repeating the process. In some instances the expansion pipes are placed directly in the rooms to be refrigerated, in which case the system is technically known as a "direct-expansion" system. In others they are immersed in tanks of brine, which, when sufficiently chilled, is circulated through refrigerating pipes in the cool chambers by means of pumps. The latter method is known as the "brine" system.

If a perfect insulation could be devised, a properly constructed storage room, when once freed of its heat and sealed, could be held at a uniform temperature indefinitely without further attention or expenditure, but as no perfect nonconductor of heat has been found, a continuation of the cooling process is necessary. In plants properly constructed and managed, equipped with duplicate machinery to provide against break downs, it is now possible to maintain definite temperatures for long periods with very slight variation, after the initial heat of the stored product has been absorbed and removed. It is this feature which gives these systems their special value in holding fruits and other perishable products.

### APPLICATION OF MECHANICAL REFRIGERATION TO FRUIT STORAGE.

Data on the history of the application of mechanical refrigeration to fruit storage are meager. At first it seems to have been limited mainly to the manufacture of ice, beer, and other products. Selfe[1] considers the rapid development in the United States to have been due more to its use in the brewery and to the national taste for iced water than to other applications, while the Australian development he considers mainly due to the desire to export meat products in the fresh state.

In the early seventies it was applied to the chilling of meats in packing houses in this country, and in 1878 the Pictet Artificial Ice Company fitted up a building in Greenwich street, near Dey, New York City, for the purpose of holding fruits, etc., in cold storage for the public.[2]

About 1881 the Mechanical Refrigerating Company of Boston opened a storage warehouse, probably the first to utilize mechanical refrigeration for storage on a large scale.

In 1878 the Western Cold Storage Company of Chicago opened a storage house chilled with ice placed in suitable bins. In 1886 the same house adopted a semimechanical system, consisting of coils of pipes through which a brine of ice and salt was circulated after being chilled in a cooling room. In 1890 an ammonia compression plant

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[1] "Machinery for refrigeration," Chicago, 1900, p. 24.
[2] Letter of John Nix & Co., New York, December 29, 1900.

was put in for cooling the brine. Fruit was stored in this house from the date of its opening.

The first establishment in the West to offer mechanical refrigeration for general storage appears to have been the Union Cold Storage and Warehouse Company of Chicago, which opened for business on Thanksgiving Day, 1889, and which stored apples in quantity in 1890, beginning on pears a year later.

From that date forward, apples were extensively stored in Chicago, and that city continues to lead all others in quantity of fruit stored. The success that followed these efforts resulted in rapid utilization of the then existing facilities for storage throughout the larger cities. Early in the nineties there was a marked increase of storage houses in the smaller cities and towns, especially those with good shipping facilities located in important apple-producing regions. This tendency appears to continue, as new storage houses with a capacity of 10,000 to 50,000 barrels, many of them constructed solely for the storage of fruits and vegetables, are being erected each year.

Official statistics of the number and capacity of refrigerated storage warehouses in the United States are not available. A commercial estimate made early in 1901[1] shows a total of 600 establishments in which fruits and produce are stored under mechanical refrigeration. The estimated capacity of these establishments is about 50,000,000 cubic feet. The total refrigerated capacity of all classes of cold storage, including meat storage, in the country is estimated by the same authority at 150,000,000 cubic feet. Until recently little has been done, outside of America, in the way of providing special facilities for refrigerated fruit storage. Such facilities are now available, however, in London, Liverpool, Glasgow, and a few other European cities.

From the perishable character of these products and the short periods for which they are held, it is, of course, impossible to ascertain to what extent these facilities are utilized for fruit storage. Of the summer fruits, such as berries, peaches, plums, and early pears, relatively small quantities are stored, though the aggregate in times of glutted markets is large. These are held but for a few days, however, as most of them rapidly deteriorate in flavor, even where they hold their form and beauty; but of pears, beginning with the Bartlett, and following with late varieties, large quantities are frequently stored for a longer period. Single houses in western New York have held as many as 25,000 barrels of Bartletts at one time, and in the city of New York the quantity occasionally reaches 40,000 barrels. These are held but for a few weeks, the "life" of this fruit under refrigeration being estimated at six to eight weeks.

Some of the larger canneries are equipped with storage chambers,

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[1] L. O. Thayer, editor Cold Storage, New York, March, 1901.

in which stocks of pears and other summer fruits can be held in sound condition until they can be canned, thus relieving the markets and reducing the waste, for which American fruit markets are notorious.

Eastern-grown stock of the later pears, such as Seckel, Angouleme, Anjou, etc., is held in smaller quantity for longer periods, and late fall and winter varieties from California, such as Angouleme, Anjou, Bosc, Clairgeau, Winter Nelis, Easter, and P. Barry, are held in considerable quantities in Eastern cities until late winter or spring. Citrous fruits are also held in considerable quantity in summer.

### IMPORTANCE OF REFRIGERATION FOR APPLES.

Notwithstanding its relatively greater durability under ordinary conditions, the apple is more largely stored than other fruits, and the apple industry has undoubtedly been benefited to a greater extent by the development of refrigerated storage than all other fruit industries combined. This is apparently due to several causes, among which may be mentioned—

(1) The liking of Americans and Europeans for the apple in preference to other fruits. They tire of most fruits if they are continually in sight, and cease to buy, but they eat and enjoy apples for at least nine months in the year where they can be had in sound condition.

(2) The apple retains its natural appearance and flavor under refrigeration for a longer time than other fruits.

So important has the question of proper distribution of this fruit become that the larger dealers have arranged a system of reporting statistics of the quantities of fruit in storage at different dates during the winter in much the same way that stocks of grain are reported to boards of trade, thus furnishing a more intelligent basis for establishing prices and making shipments than has heretofore been thought possible. These figures illustrate the magnitude of the industry. For the past three years these estimates, made by the executive committee of the National Apple Shippers' Association, have been as follows:

*Estimated quantity of apples in common and cold storage, 1898–1900, inclusive.*

[Estimated refrigerating capacity of United States in 1900, 5,000,000 barrels.]

| Year. | Common storage. | Cold storage. |
|---|---|---|
| | *Barrels.* | *Barrels.* |
| December 1, 1898 | 400,000 | 800,000 |
| December 1, 1899 | 634,500 | 1,518,750 |
| December 1, 1900 | 792,000 | 1,225,000 |

The greatest usefulness of refrigeration for the apple is now, and probably will continue to be, in the Middle States, where the long, warm falls and unsettled winters make cellar storage uncertain at all times, even with the more durable varieties. It is evident, however, that in many seasons refrigerated storage in the great apple districts of the North greatly lengthens the marketing season, and permits profitable distribution of the fruit.

There can be no question that in the large cities it will be more extensively used in the future than it has been, for dealers have come to look upon it in the light of insurance against loss from sudden rises of temperature, and feel that in large operations they can not afford to carry the risk incurred in common storage. Single firms handle upward of 100,000 barrels of apples per annum, and as the expense for packages and for packing, forwarding and handling, is estimated at about $1 per barrel for that destined for American markets, in addition to the original cost of the fruit, the reasons for this belief are apparent.

Its greatest direct benefits to the apple producer have probably come through the prompt withdrawal from market at the harvest time of a large part of the best fruit, which alone it will pay to store. In this way prices of good fruit are less likely to be depressed, and the average price of good apples throughout the year is undoubtedly higher than would have been possible without refrigeration. It is noticeably true in our large cities at the present time that the visible supply of choice winter apples on the market is smaller in October and November, at the height of the receiving season, than later in the winter. Yet, upon inquiry, choice fruit can be found in the storage establishments, where it is held in reserve for later sales.

This is especially true of certain delicate and high-flavored varieties that are normally short lived, such as Northern Spy, Jonathan, and Grimes, which have been found to endure refrigeration well and to bring much higher prices later in the winter than if sold in the fall. There are limits, however, beyond which the retardation of these fancy varieties can not be carried with profit, and these are yet to be ascertained by careful experiment. Many points in connection with the subject are yet unsettled. Thus, the proper temperatures for fruits in different stages of ripeness and for varieties of different characteristics; the comparative effect of sudden versus slow chilling of the fruit when placed in storage; the relative merit of tight versus ventilated packages, of wrapped versus unwrapped fruit, and of various methods of packing in relation to the discoloration known as "barrel scald;" and the effect of different temperatures upon the ultimate flavor and chemical composition of the fruit when it reaches the consumer—all these need thorough investigation. Little systematic work has yet been done along these lines, most of the commercial experiments having lacked the exactness necessary to give them permanent value.

The fact that some of the choice varieties of apples that were formerly unprofitable because of their poor keeping quality can now be profitably grown and safely stored is working a gradual change in the character of varieties planted by making their culture profitable in commercial orchards. This promises to become the most important factor in raising the quality of our commercial orchard products.

It was at one time thought by some that refrigeration had solved the problem of the future supply of home-grown fruit in the Northern prairie States, where most of the varieties possessing sufficient hardiness of wood to endure the winters are summer or early autumn apples. Thus, it was thought that hardy winter varieties would be unnecessary, as the summer fruit could be stored and take its place. This, however, has not proved true in practice. Most of the Russian and other hardy sorts have proved poorly adapted to long keeping in refrigeration. Late summer and autumn varieties, like Oldenburg, Alexander, and Wealthy, can be held until midwinter, but can not be depended upon later than that. Refrigeration does not make poor apples good. The need for a hardy winter apple of good quality is, therefore, still urgent, if the population of the Upper Mississippi Valley is to eat fruit of its own raising.

### EFFECT OF REFRIGERATION UPON THE APPLE TRADE.

As the earlier storage establishments were in the larger cities, dealers have utilized them to a much larger extent than have producers. Where producers have sufficient quantity and are near enough to a storage establishment, they can often store their own fruit with profit, as the storage rates charged by most establishments are reasonable, considering the service rendered. Where a grower has a large crop of choice fruit and handles it properly in harvesting, assorting, and packing, it is unquestionably often possible for him to realize more by storing than by selling in the fall.

Most storage establishments store apples in carload lots at about 40 cents per barrel for the season ending May 1, and it is rarely the case that sound fruit does not advance more than that in price by March 1, while a rise of $1, or even $1.50, per barrel is not infrequent. In some instances market houses are equipped with storage facilities, so that the grower can store in the fall and yet have access to his fruit for sales on market days each week during the season. This gives him a great advantage, as he is able to conduct a retail trade without the intervention of the middleman. One of the best examples of a storage house of this kind is the Reading Terminal Market, of Philadelphia, illustrated on Pl. LXXI.

The necessity for careful grading and packing of apples has been made clear by experience with fruit in refrigeration as never before. Unsound fruit will not keep, and the folly of investing storage charges

FIG. 1.—READING TERMINAL MARKET, PHILADELPHIA, PA.

FIG. 2.—PRODUCE STANDS IN READING TERMINAL MARKET, PHILADELPHIA, PA.

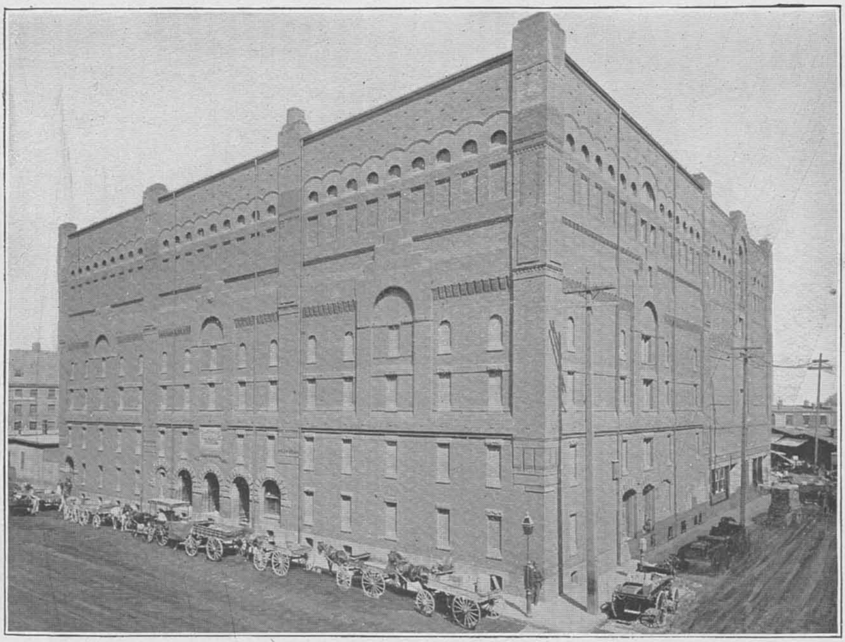

FIG. 1.—RICHMOND STREET WAREHOUSE, QUINCY MARKET COLD STORAGE COMPANY, BOSTON, MASS.

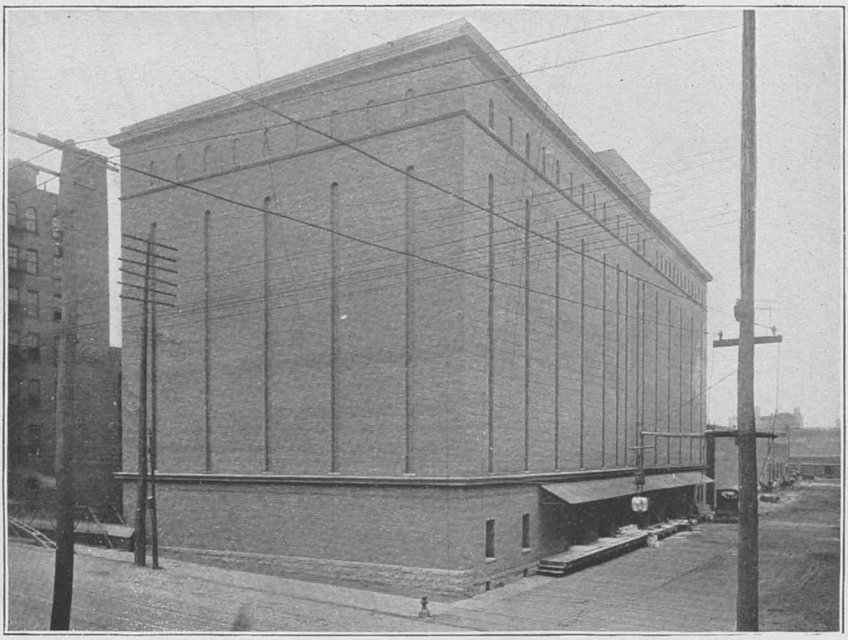

FIG. 2.—BUFFALO COLD STORAGE COMPANY, BUFFALO, N. Y.


FIG. 1.—UNION COLD STORAGE AND WAREHOUSE COMPANY, CHICAGO, ILL. THE FIRST MECHANICAL COLD STORAGE IN THE WEST.

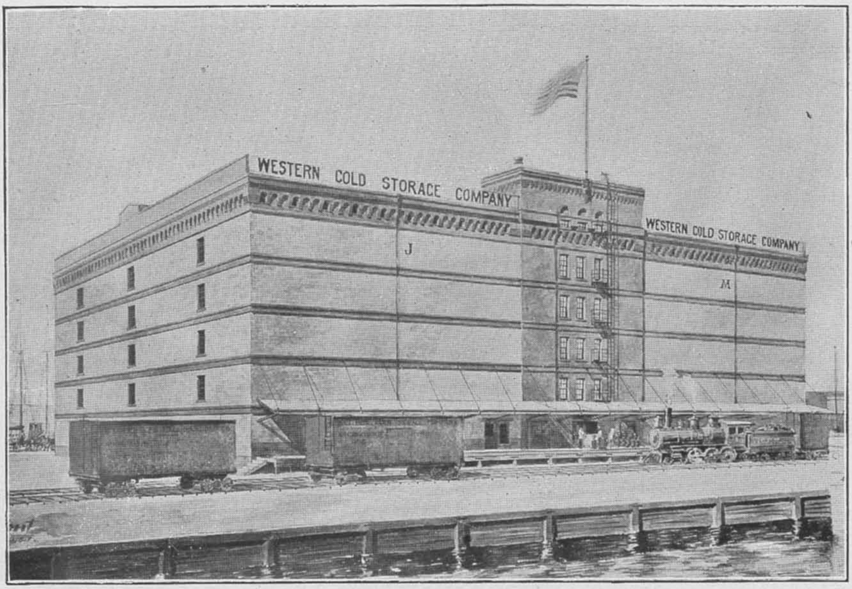


FIG. 2.—WESTERN COLD STORAGE COMPANY, CHICAGO, ILL.

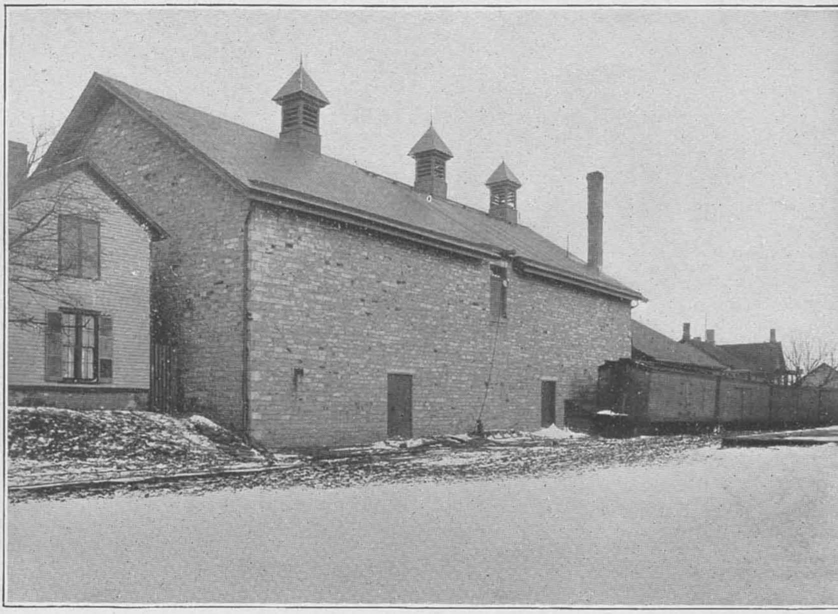

FIG. 1.—APPLE STORAGE HOUSE, BUILT FOR THE USE OF E. P. LOOMIS & CO., SPENCERPORT, N. Y. CAPACITY, 10,000 BARRELS.


FIG. 2.—ICE AND COLD STORAGE COMPANY, LOS ANGELES, CAL.

in it has been demonstrated by dealers in numerous instances. So important is this matter considered that many dealers now decline to purchase apples for storage not packed by their own trained employees, except where they have personal knowledge of the carefulness and competence of the packer. A distinct improvement in the grading and packing of this fruit is already evident, though much yet remains to be done in most sections to bring the average up to the proper level. Cooperative packing houses may be the ultimate outcome of this in regions where orchards are small, in order that uniform grading and packing may be established.

Cooperative storage houses have been suggested, and even individual storage houses on the larger farms. These are possible, but, in view of the relatively large cost of operating small houses in most sections and the difficulty of securing competent engineers, their economy appears very uncertain except when they can be operated in connection with creameries or other establishments requiring skilled labor and continuous operation.

The question whether fruits like the apple can be stored to best advantage in country towns or in large cities is two-sided. The large city house undoubtedly affords some advantages. Among them, are the fact that fruit can be delivered to consumers on short notice in all kinds of weather, and that, if on the seaboard, apples can safely be withdrawn from storage for exportation at almost any time. The haul to such houses from the orchard requires a longer time, however, and in the event that hot weather occurs while the fruit is in transit, the danger from loss by deterioration in keeping quality is greatly increased. All dealers and storage men agree that fruit for long keeping should be placed in storage as soon as possible after removal from the tree, and this is more easily accomplished if the storage house is within wagon-hauling distance or a short haul by rail.

The smaller investment for land, lower rates of taxation, and generally lower labor cost should make storage in the smaller places as low in cost as in the large cities, if not lower, though these items are counterbalanced, in part at least, by the greater economies possible in the operation of a large plant.

Some of the larger city plants are shown on Pls. LXXII and LXXIII, and representative smaller plants in lesser places on Pl. LXXIV.

## REFRIGERATION IN TRANSIT.

Even more important than cold storage to fruit growers in many sections are facilities for transporting their fruit in sound condition for long distances. In fact, as already noted, the very existence of commercial fruit growing remote from centers of population depends upon the maintenance of adequate facilities for transportation. The great bulk of rail shipments in the early days went to market in freight cars, but it was soon found that losses from deterioration in transit were too frequent and too large to leave a profit to the shipper. Ventilated cars of various kinds were tried with varying success, the first carload shipments of deciduous fresh fruits from California, consisting of 33 tons of pears, apples, grapes, and plums, having been successfully made in them in 1869. All shipments from California prior to 1888 were thus made, carefully selected foothill fruit enduring the journey to Chicago, or even farther east, where the trains were moved on express schedules. Valley fruits and those from irrigated lands, however, could not be safely shipped.

Encouraged, no doubt, by the measure of success attained in preserving fruits and meats by ice storage, experiments were made by many individuals in the direction of chilling cars while in transit. The first patent taken out for a refrigerator car was that of J. B. Sutherland, of Detroit, Mich., under date of November 26, 1867. Other inventions were patented in rapid succession by persons residing in different parts of the country. Shipments of fresh meat were made during the early sixties, and perhaps earlier, in ordinary freight cars. These were fitted up with platforms at each end, upon each of which was placed about 3,000 pounds of block ice. The ice was held in place by stout swing doors suspended from the ceiling, and the ice could only be replaced when the car was empty. About 1868 Mr. D. B. Beemer[1] states that he and the late H. P. Stanley, tempted by the high prices for peaches then prevailing on the New York market on account of the failure of the crop in Delaware and New Jersey, undertook to forward from Chicago a carload of Michigan Oldmixon and Late Crawford peaches in one of the meat cars then in use on the Michigan Central Railroad. The car was iced and loaded with warm fruit from South Water street, and started, attached to a passenger train, for Suspension Bridge, N. Y., thence to be forwarded by fast freight to New York City. The total time in transit was to be about three days. When Suspension Bridge was reached, twenty-three hours after departure from Chicago, the car was opened and the contents were found to be in bad condition, the ice having melted. The losses to the shippers on this and another car forwarded by the same method amounted to about $1,000 per carload. The failure was due to the warmth of the fruit when shipped and the lack of facilities for re-icing in transit.

In the same year, 1868, Mr. D. W. Davis, of Detroit, Mich., who had been engaged in experimental work on this line since 1865, perfected a refrigerator car, which he patented June 16 and September 15 of that year. In this car, which was carefully insulated, galvanized-iron tanks, to contain a freezing mixture of ice and salt, were arranged

[1] Ice and Refrigeration, September, 1894, p. 165.

along the sides, and so placed that they could be refilled from the top without entering the car. By refilling these tanks with sufficient regularity a fairly uniform temperature of 34° to 40° could be maintained. In this car strawberries were reported to have been successfully shipped from Cobden, Ill., to Buffalo, N. Y., and peaches from Dayton, Ohio, to New York City in sound condition, though each lot is said to have been ten days in transit. A successful shipment of dressed beef to Boston, made in September, 1869, in this car is credited with being the beginning of the dressed-beef industry, which soon attained large dimensions.

Even earlier than this Mr. Parker Earle, then of Cobden, Ill., had shipped strawberries in refrigerator chests by express as far as Chicago, New York, and New Orleans. These held about 200 quart baskets of berries each and 100 pounds of ice. They carried the fruit well for long distances when properly re-iced, but were finally abandoned because of the heavy express charges on the refrigerators and the failure of the express companies to re-ice them in transit. Mr. Earle tested various refrigerator cars, mostly built for the dairy and meat trade, including the "Davis," above mentioned, and finally settled upon one, the "Tiffany," which was cooled by about 3,000 pounds of ice, in a V-shaped box running the full length of the car. By cooling the fruit in an ice house before shipment he was able to deliver strawberries and other perishable fruits in Chicago, Detroit, and other Northern cities in better condition than had been done before. To his energy, skill, and persistence the early development of the refrigerator-car service of the Mississippi Valley and Gulf regions is largely due.[1]

From this date forward several railroads built and operated refrigerator cars over their lines, and fruits were carried in them to a greater or less extent. The results were quite uncertain, however, and the outlook discouraging until about 1887, when Mr. F. A. Thomas, of Chicago, entered the field with Mr. Earle and revolutionized the business of fresh-fruit transportation. His plan was to provide a through service from shipping point to destination in special cars under one management, re-icing the cars in transit as found necessary. It was, in short, the establishment of a private-car line for fruit transportation, to be operated on a plan similar to that under which sleeping cars had long been run in the passenger service. He commenced operations with a few cars in western Tennessee in the spring of 1887, operating first on strawberries destined for the Chicago markets. Owing to the distrust of shippers in regard to the effect of ice upon the fruit he was compelled to buy fruit with which to fill them for shipment. A few tests demonstrated the practicability of the system, however, and the new service rapidly became popular.

[1] A fuller account of Mr. Earle's work is given in a separate article ("Development of the trucking interests") in this Yearbook.—Ed.

Fruit forwarded in carload lots by freight to Chicago under this plan could be distributed to other points in small lots by express and reach destinations as remote as Minneapolis in sound condition, while cars properly iced and filled with fruit were found to hold their contents in good condition for several days, thus protecting against damage due to ordinary delays in transit. In the spring of 1888 Mr. Thomas shipped strawberries from Florida successfully in refrigerator cars.

In 1887, also, some of the cars were taken to California and after much persuasion, shippers were induced to try them. All California deciduous fresh fruits prior to that time had gone forward in ventilated cars without ice, and solid fruit trains had for several years been run on express-train schedules from Sacramento to Chicago. The belief was general that fruit shipped in iced cars would be injured in flavor and in keeping quality after removal from the cars, but this proved not to be the case. In the latter part of June, 1888, a carload of ripe apricots and cherries was successfully shipped from Suisun, Cal., to New York without re-icing. The experience of the season of 1888 demonstrated beyond all question the usefulness and practicability of the refrigerator car when properly handled.

In 1889 Mr. Thomas entered largely into the distribution of the Michigan peach crop, which prior to that time had been principally consumed in the cities of Chicago and Milwaukee. As a large part of the producing territory was not easily accessible to railroads, portions of the holds of two steamers, the *Douglas* and the *Pilgrim*, plying between Saugatuck, Mich., and Chicago, a distance of about 90 miles, were leased for the season. These compartments were chilled with ice, so that the fruit when transferred from the steamer to the refrigerator car on the dock in Chicago was thoroughly cooled. It could then be safely transported several hundred miles. The rehandling necessary by this method was expensive, however, and injured the fruit, so that it has not since been attempted on a large scale. Direct shipments in refrigerator cars to the Atlantic seaboard from the same region are now regularly made.

Development after that was rapid. From a total of sixty cars in service in 1888, the company which Mr. Thomas organized increased its facilities, until by 1891 it had in use over six hundred cars. These traveled over various railroads as needed, being used for Florida fruit in winter and Louisiana and Mississippi strawberries in spring, gradually working northward as the ripening season progressed, with long trips out to the Pacific coast in July, August, and September. Their usefulness did not cease with the approach of winter, for they protected their contents against a considerable degree of cold, and when heated could be safely used in severe cold weather.

The larger plantings, stimulated by the refrigerator-car service, soon made possible the loading of cars at single shipping points or at

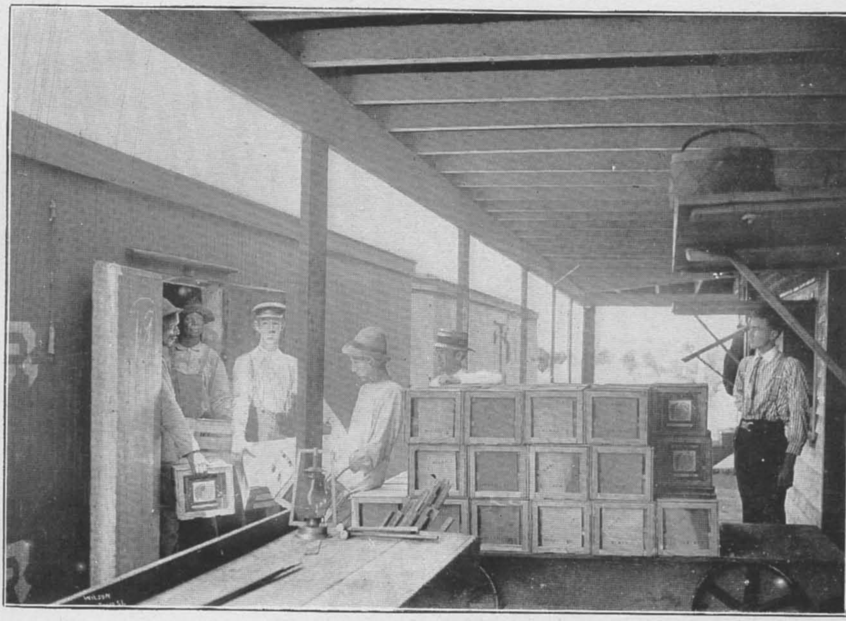

FIG. 1.—LOADING REFRIGERATOR CARS FROM PEACH PACKING HOUSE IN GEORGIA.

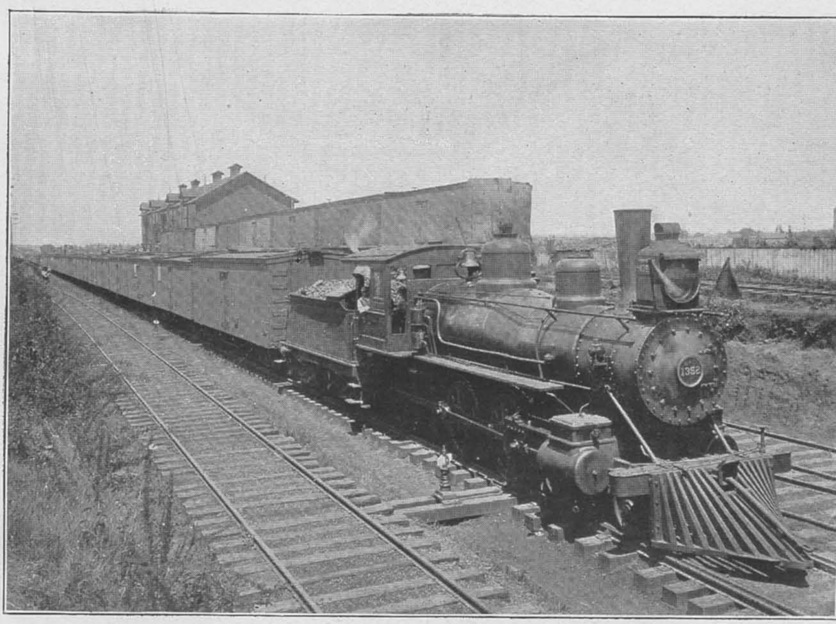

FIG. 2.—TRAIN LOAD OF PEACHES AT ICING STATION IN GEORGIA.

a few points along a line of road, so that small growers now have the same advantage as large shippers except in the matter of carload rates.

In recent years the business of operating refrigerator cars has been taken up by many lines, so that there are now probably fifty or more different private car lines in service of various kinds, in addition to similar cars operated by many of the railroads that traverse fruit-producing regions. The fruit is in many sections loaded from the packing house, where it is protected from the heat of the sun, directly into the cold refrigerator car (Pl. LXXV, fig. 1), from which it is not removed until it reaches its destination, 1,000, 2,000, or 3,000 miles away. From the important fruit sections these cars are moved in solid trains to the principal markets (Pl. LXXV, fig. 2). Capacious icing stations established at intervals along the main routes of travel permit re-icing of the cars with the utmost dispatch.

Official statistics of the number of refrigerator cars in service are lacking, owing to the failure of some of the car lines to report the number of cars owned and operated by them. A careful estimate by the manager of the Railway Equipment Register[1] in March, 1901, indicates that there were at that time about 60,000 refrigerator cars in service in the United States, Canada, and Mexico.

No basis exists for estimating the total volume of produce handled by these cars, but it is very large. Leading shippers estimate that 95 per cent of the California deciduous fresh fruits are now handled in them, and the proportion from other sections is steadily growing. Small-fruit and orchard areas in the more remote regions adapted to fruit culture are steadily growing under the influence of this service, and producers are enabled to profitably diversify their production as never before.

The length of time during which the summer fruits can be safely held in refrigerated cars in transit varies greatly, depending upon the conditions under which the fruit is grown, the variety, the ripeness, package, handling, etc. From two to five days for strawberries and six to eight days for peaches and plums may be taken as the ordinary safe periods for Eastern fruits.

Most of the deciduous fruits from California can be delivered in fairly good condition to any portion of the United States within ten days by rail, but the opinion of the growers on the proper time for fruit to be in transit may be judged from the fact that they are now urging upon the railroads a six-day schedule from Sacramento to Chicago, with eight days to New York. Certain fruits, in exceptional instances, however, have endured much longer than this. In 1894 one carload of peaches and Tragedy prunes which, on account of

[1] Letter of J. Alexander Brown, manager Railway Equipment Register, New York, March 15, 1901.

railroad strikes, was held in the railroad yards in Sacramento for seventeen days, reached New York in July, twenty-six days after loading, and sold at extremely high prices, the peaches bringing $5.50 per 20-pound box and the prunes $3 to $4.15 per crate of about 20 pounds. The fruit, though apparently sound, spoiled quickly after being placed on the market, however, showing that the limit of safety had been passed.[1]

### OCEAN REFRIGERATION.

As would be expected, the early efforts in fruit refrigeration on the ocean were made in connection with the export trade in ice from New England early in the last century. This trade carried American apples literally "on ice," first to the West Indies, later to the more important tropical maritime cities of the globe, including those of India, China, and Australia. It never attained large proportions, however, owing to the excessive prices at which fruit thus transported must be sold to yield profit to the shipper.

Shipments of fruit in mechanical refrigeration on steamers do not appear to have been made until after the Australian meat trade, which began in 1880, was well established. Small quantities of apples were forwarded in connection with consignments of frozen mutton from time to time. These, reaching London in the spring, when fruit was scarce, brought high prices, and on May 5, 1888, the Peninsular and Oriental Company's steamer *Oceana* sailed from Melbourne with 500 tons of Australian and Tasmanian apples in refrigeration as an experimental shipment. These reached London June 12, mostly in sound condition, and marked the beginning of commercial fruit refrigeration on the ocean. Later shipments included pears and oranges, both of which fruits go through in fair condition when properly handled, notwithstanding the fact that the trip requires thirty-seven to forty days and involves the crossing of the torrid zone. The fact that the fruit is shipped fresh from the tree and can be allowed to ripen slowly while in transit simplifies the problem somewhat, however, as a temperature of 40° is found to be low enough to protect against too rapid ripening. The trade is yet limited to apples, pears, and oranges, though some shipments of grapes have gone through in sound condition. In this connection it should be noted that in 1893, at the Columbian Exposition in Chicago, the New South Wales exhibit contained a collection of ten varieties of apples, together with oranges and lemons, forwarded to Chicago in two lots, one via San Francisco, which was fifty-two days in transit and the other via New York, which was several days longer. These exhibits demonstrated in a manner most convincing the usefulness and the possibilities of refrigeration in fruit forwarding as developed in Australasia.

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[1] Letter of N. R. Salsbury, New York, February, 1901.

Three steamers are at the present writing being equipped in England solely for the Australian fruit trade, and as the requirements of this trade are quite distinct from those of the meat and dairy produce trade, with which it has heretofore been associated, better results may reasonably be expected than have yet been accomplished.

From the Cape of Good Hope small shipments to London of peaches, plums, nectarines, pears, and grapes have been made since 1891 with varying success, latterly with almost uniformly good results both as to condition of fruit on arrival and prices obtained for same. American nursery stock has been going forward to South Africa in carload lots for some years, and a large increase in the surplus product from there may be expected in the near future.

Neither the Australasian nor the South African fresh fruit competes seriously in European markets with any American fruits, except refrigerated pears and apples, but on these there is likely to be sharp competition in future.

Export shipments of American dressed beef began in 1876, but shipments of fruit under mechanical refrigeration do not appear to have been attempted until several years later.

In the spring of 1892 experimental carload lots of tomatoes from Florida were shipped to England, the first going forward from New York on the steamer *Majestic* April 27. Later in the season five shipments of California peaches, pears, and plums, aggregating twenty-four carloads of 20,000 pounds each, were forwarded to Liverpool from New York. These shipments were made in refrigerated compartments containing four or five carloads each, the latter quantity being required to fill a compartment. The departure of the fruit from California was timed to correspond with the sailing date of the ship for which it was destined, and the total time from shipping point to Liverpool and London was seventeen to eighteen days. The gross sales of the twenty-four carloads amounted to about $32,000, but the heavy expense of forwarding by this method left no profit to the shippers. With a good deal of fluctuation, these export shipments of summer fruits have continued from year to year, however, and they show a gradual growth. Longer experience in handling has made it possible to deliver peaches, pears, and plums from California in London in sound condition, almost without failure. The uncertain question from the commercial standpoint now is the condition of the market on arrival. If bare of English and French fruits, prices sufficiently high to leave a profit are obtained, otherwise not. With lower ocean transportation and refrigeration rates a considerable increase could be made with profit, as the fruit can now be placed on the London market within fifteen to seventeen days from the tree in California.

Few efforts to forward Eastern-grown deciduous fruits to Europe in refrigeration have been made owing to the difficulty of securing the necessary space for small lots, the present facilities between the United States and Europe being in the form of large compartments, utilized chiefly in the forwarding of dressed meats. The most pressing need at the present time is apparently for smaller chambers, in which lots of fruit can go forward at a definite rate per package in the same way as in refrigerator-car shipment. That such service would permit of the delivery of peaches, plums, summer pears, and apples in sound condition in almost any of the large cities of Europe was demonstrated by the shipment of these fruits from several States to the Paris Exposition in 1900. These fruits, carried by courtesy of the steamship officers in the ships' refrigerators on the American line from New York to Southampton, were delivered in Paris in excellent condition nine or ten days out from New York and about ten or twelve days after removal from the tree. As an illustration of what is possible with modern facilities, it should be said that one shipment was delivered in Paris in eight days and eighteen hours from New York.

Since 1897 several shipments each year of grapes, peaches, plums, summer apples, and pears from Canada to British markets have been made on the subsidized refrigerated steamers controlled by the Dominion government. These have usually reached their destination in sound condition and sold at encouraging prices.

The most promising feature of the export outlook for the future is for the increased shipments of American apples and oranges.

In the production of both of these fruits America stands first in quantity as well as in beauty and quality of product. Both ship well when properly handled, and meet with ready demand throughout northern and western Europe. Both need ocean refrigeration during portions of the season, at least, and present facilities for this are inadequate. Where apples have been stored in refrigeration during the winter, serious risk is involved in shipping in common stowage toward spring, when the prices are usually highest, while, with refrigeration on cars and steamer, shipments can be safely made at almost any time of year. For Pacific coast products, including both apples and oranges, the long and expensive haul by rail will probably militate against a large development of exports of these fruits until the construction of an isthmian canal shall make possible the forwarding by cheaper water transportation without rehandling. Speed is of less importance for these fruits than uniform temperature and freedom from unnecessary jarring and bruising. Both of these conditions can be obtained in a properly regulated steamship service, as has been demonstrated in the Australasian trade, and will probably soon be witnessed in the Canadian experiments, where a chain of cold storage houses in the producing sections has recently been supplemented with a frequent ocean service affording refrigeration in compartments of convenient size.

# OUR NATIVE PASTURE PLANTS.

By F. Lamson-Scribner,

*Agrostologist.*

## INTRODUCTION.

Pastoral pursuits were among the first peaceful industries to engage the attention of man, and to-day the pastoral industries of the greatest nations surpass all others in importance and are second to none in actual money value. The great grazing regions of the world are the steppes of Russia, the pampas of South America, the almost boundless pastures of Australia (supporting more than 112,000,000 sheep and yielding one-fourth of all the world's supply of wool), and the vast plains and mountain slopes of the interior of our own country. In a broad sense, these are the world's great pasture lands, and the pasturage they supply furnishes the bulk of the world's beef, wool, and other animal products entering into its commerce. The cattle, horses, and sheep of the United States number over 100,000,000, valued at $1,829,000,000. The vast capital these represent is absolutely dependent upon the greatest of all our natural resources, our grasses and forage plants. These annually sustain industries valued at nearly $2,000,000,000, industries upon which the very existence of the human race is dependent. The figures giving the value of all our beef consumed at home and abroad, our mutton, our milk, butter, and cheese, and the hides and wool, and numerous other animal products which minister to our pleasure and comfort, show a surprising multiplication of industries dependent upon our forage supplies. The amount of hay produced in the United States is estimated in round numbers at 70,000,000 tons—scarcely more than enough to feed our cattle, horses, and sheep during three months of the year. This hay crop, valued at $400,000,000, must be supplemented by 210,000,000 tons from other sources. This amount, or 75 per cent of the hay and forage necessary to maintain our stock, is furnished by our pastures and grazing lands. The question of what does this pasturage consist is thus an exceedingly interesting one, and almost equally interesting, and even more important, is that of how shall this forage supply be maintained and its productiveness and feeding value increased.

While it is true that the bulk of our hay crop, possibly 95 per cent, or even more, is composed of grasses and other plants introduced from foreign countries, it is equally true that the bulk of our pasturage is composed of grasses and fodder plants indigenous to the soil.

It may be safely stated that 98 per cent of our pasture plants are natives. This is especially true of the cattle ranges of the West. It will be seen, then, that our supply includes practically all of our native grasses; and many plants of other families upon which cattle depend more or less for subsistence—for the cattle range over all our wild lands, and the grasses with which these lands abound, numbering throughout the country many hundreds of species, every one producing a mite at least of the general forage supply—may be classed with our native pasture plants. To enumerate them all would be wearisome; and we must be content to consider those regarded as of special importance, either on account of their abundance or adaptation to peculiar conditions. Our native pasture plants vary according to the soil and climate, especially as these are affected by altitude and latitude, and, owing to the breadth of our territory and dividing mountain chains, great variation also occurs with change of longitude. We can broadly classify our pasture plants into those of the wooded regions and those of the treeless areas; the former occur both upon the Atlantic and Pacific slopes, and the latter occupy the vast interior of the country.

The characteristic grasses of the wooded areas, or of those regions where the rainfall exceeds 25 or 30 inches, produce a continuous turf or sod, while those of the treeless plains and foothills of the mountain ranges in the interior and of the desert regions, the so-called bunch grasses, do not form a continuous sod, but grow in more or less scattered tufts or bunches. The Western stockman has long been familiar with these bunch grasses of the cattle ranges, and justly prizes them for their nutritious and fattening qualities, while the Eastern farmer knows only those grasses which make a clean, unbroken sod and a rich, succulent growth, such as is formed by Kentucky blue grass, the best and most highly prized of all turf-forming species. It is true that bunch grasses occur in the wooded regions of the East, and it is also true that turf-forming grasses are found in the arid, treeless regions of the interior, but such are the exception, and their presence does not conflict with the general statements here made.

### GRASSES OF THE WOODED REGIONS.

The wooded regions, as here understood, include nearly all the region east of the one hundredth meridian and a portion of the territory along the Pacific coast west of the Cascades and Coast Range and the wooded mountains of the interior. Over most of this region the rainfall exceeds 30 inches per annum, an amount sufficient to insure continual summer growth. This area is not uniform, but is so varied that several distinct regions may be defined, each of which possesses characteristic pastoral species. The region embracing the New England and Middle States and extending westward to the Mississippi

River constitutes a district in which the native pasture plants are quite characteristic, and species which have been introduced for cultivation for hay or other purposes are quite generally cultivated throughout this entire section. There is much variation in the excellence of the pasturage, largely depending upon the management by individual farmers. For the most part the pastures are comparatively small in extent, and too often they consist of lands unfit for cultivation, which at best will produce but a scanty growth of forage. The wood lot on many farms forms a part of the pasture lands, and woodland grasses contribute much valuable feed. Their growth is scattering, however, and were it not for many low shrubs and wild pea vines and beggar weeds, eaten eagerly by cattle and other stock, these animals would fare badly. Lowlying grounds furnish the greatest variety of species, and there is scarcely a farm of 150 to 250 acres in the East, consisting, as is usually the case, of woodland, meadows, and pastures, on which from 80 to 100 indigenous grasses may not be found. Along the streams and borders of low thickets the fowl meadow grasses (*Poa serotina* and *Panicularia nervata*) are abundant; so also with Manna grass (*Panicularia americana*, fig. 75), some of the Muhlenbergias, for example, the Mexican drop seed (*Muhlenbergia mexicana*); and, best of all, the blue joint of the New England farm (*Calamagrostis canadensis*). These are all tall, leafy grasses, often attaining a height of 3 feet or more, and, while affording much food to wandering stock, they are also valuable hay grasses in the sections in which they occur. In some parts of Michigan and other Northwestern States, blue joint (Calamagrostis) covers large areas and furnishes abundant hay crops of the finest quality. In the open grounds our Eastern pastures too often contain such plants as only indicate a neglected and impoverished soil. This, however, is not universally true, because there are pastures within this


FIG. 75.—Manna grass (*Panicularia americana*).

region which, on account of natural advantages or careful management, are of superlative excellence. Such are the pastures in the most thrifty dairy regions and those of the famous blue-grass regions of Kentucky. Blue grass (Pl. LXXVI) is the prevailing element in the pastures throughout all the country under consideration, but its greatest development is attained in the limestone regions of Kentucky, Missouri, and Iowa, and the cattle and horses of these great States feed upon pastures composed almost exclusively of this species. It is the natural product of these soils and uncultivated lands; and, if kept free from weeds by pasturing, it will soon present a continuous blue-grass sod. It is on account of the fine development of this grass in Kentucky that it has come to be known as "Kentucky blue grass." Its growth, as already indicated, is not limited to that State, but extends all over North America from the Atlantic to the Pacific and northward to the Arctic regions; in fact, Kentucky blue grass in some of its varieties is indigenous to all countries of the Northern Hemisphere. It is not the intention in this paper to discuss those grasses which come in and occupy the land where better sorts may be grown by proper cultivation. Such pasture grasses and such other plants of this class doubtless have their mission, and afford food of inferior quality to horses and cattle which the thriftless farmer has neglected to properly care for. The rocky New England pastures are thus often covered with a meager growth of the small wild oat grass (*Danthonia spicata*), and in other sections spiny weeds and broom sedge supply a ration that should be furnished by Kentucky blue grass and clover.

FIG. 76.—Redtop (*Agrostis alba*).

Hardly less important than Kentucky blue grass, especially in the region near the coast, is redtop (*Agrostis alba*, fig. 76). Like blue grass, redtop has a very wide distribution, extending throughout the


KENTUCKY BLUE GRASS (POA PRATENSIS).

[From photograph.]

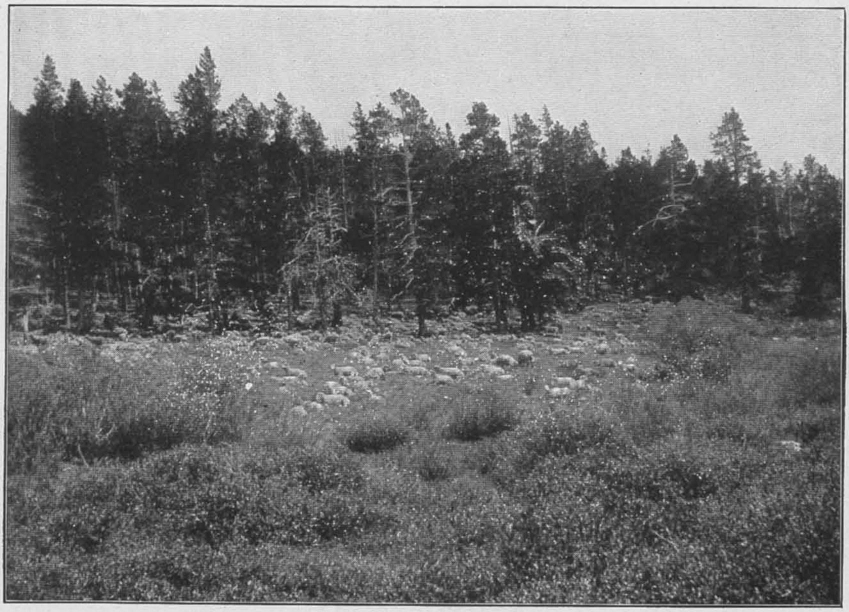

FIG. 1.—A MOUNTAIN MEADOW IN COLORADO.
[From photograph.]

FIG. 2.—GIANT RYE GRASS (ELYMUS CONDENSATUS).
[From photograph.]

temperate regions in both hemispheres. Many of the old pastures in New England, subject to the influence of ocean winds, consist almost entirely of redtop sod. There are many varieties of redtop, some of which have received distinct botanical names, and perhaps represent good species. They vary exceedingly in the height of the stem and in the fineness of leaf, but they are all good turf formers and yield excellent pasturage. Some of the forms appear to have become adapted to inland conditions, and in the open parks of the wooded regions of the Rocky Mountains other species of Agrostis form no inconsiderable portion of the available pasture grasses. Here are forms resembling dog's bent (*Agrostis canina*), others which differ but little from the common redtop, and others again which in their habits are peculiar to the locality, all yielding a greater amount of forage than the more familiar kinds.

MOUNTAIN MEADOWS AND DEER PARKS.

As properly belonging to the general region under discussion, the cooler temperate region, we may here refer to the mountain meadows and deer parks, which constitute a feature of considerable importance because of their area in the mountain regions of both the Eastern and Western portions of the United States. There are many such parks along the Alleghenies, especially in the southern portion, and in the early spring the farmers in the valleys drive their young cattle to these elevated pasture lands, where they find abundant feed during the summer months. These mountain parks (Pl. LXXVII, fig. 1) are similarly utilized by the stock owners of the far West, and the grasses of these summer ranges often carry large bands of sheep and cattle through periods when the forage of the valleys is wholly insufficient, and furthermore may be unavailable on account of the absence of water. There is usually an abundance of water in these parks, and the herbage is comparable with that of the pastures of the settled portions of the East. The grasses they contain include a number of species, those of the Alleghenies being mostly blue grasses with an occasional mixture of fescues and the wild oat grass, a variety which has been named Tennessee oat grass (*Danthonia compressa*) because of its abundance in the mountain meadows of that State. There are many blue grasses in the deer parks of the Rocky Mountains, more common there than the Kentucky blue grass, whose place they supply on these mountain soils. Some of them manifest a productiveness equal to that of the best blue-grass pastures of Kentucky. Wheeler's blue grass, Nevada blue grass (fig. 77), Fendler's blue grass, and a variety known in the mountains of New Mexico as "mutton grass" are species of this class. Nowhere in this country are the finer fescues more abundant than in the woodland parks of the Rocky Mountains. Sheep fescue and red fescue exist in many varieties, and there are others which assume the form of great bunch grasses, valuable alike for pasturage and hay. The Danthonias are among the pasture grasses of these mountain parks. In the East we have one of these under the name of Tennessee oat grass, already mentioned. In the West is the California oat grass (*Danthonia californica*), and one which we may call mountain oat grass (*Danthonia intermedia*), two species of much economic value in certain sections of Oregon, Washington, and California.

There are many herds of cattle which find rich pastures west of the Coast Range. The grasses of this region are numerous, and, owing to the abundance of moisture, not only from frequent rainfall, but from the direct influence of the ocean winds, fine pasture grasses abound. There are many of the bent grasses or Agrostis species, botanically different from those of the Atlantic coast, but no less productive or nutritious. These bent grasses are more numerous in species on the west coast than on the east. They are preeminently pasture grasses whose tender substance affords palatable food for all kinds of stock. The fescues of this region extend to the very sands on the beach and oftentimes cover areas of large extent. Both varieties of the sheep's fescue and of the red fescue abound on all lighter soils; on heavier lands other species occur, including the California fescue (*Festuca californica*), a species of remarkable growth, and others having a striking resemblance to the meadow fescue of Europe, doubtless equally as valuable. Many blue joints belonging to the genus Calamagrostis and some of the hair grasses (Deschampsia), as well as the California oat grass, are not infrequent. The characteristic pasture plants of this region are the bent grasses and fescues. Some of the best dairy herds of this country are found in the narrow strip of land bordering the Pacific coast, and butter, especially prized for the fineness of its flavor, is the product of the native grasses of these pastures.

FIG. 77.—Nevada blue grass (*Poa nevadensis*).

SOUTHERN STATES.

Passing from the cooler temperate regions to the warmer Southern States, east of the one hundredth meridian, we have presented a pasturage composed of new grasses characteristic of the region. The fescues and the blue grasses are wholly wanting, their places being taken by the water grasses (species of Paspalum), wire grasses (species of Aristida), panic grasses, and a few others. The Paspalums and the wire grasses, in their season, yield a large amount of forage, and the former are highly esteemed by many, especially the large water grass (*Paspalum dilatatum*, fig. 78) and carpet grass (*P. compressum*). In the rich pastures of the prairie regions of Louisiana the Paspalums are the characteristic species, and where the land has been grazed for some time carpet grass is predominant. In many localities the southern cane, a species of bamboo (Arundinaria) covers large areas known as canebrakes. Thousands of cattle range in these canebrakes throughout the entire year, securing a living by grazing on the young stems and rather harsh leaves. In the uplands of the pine-woods region the wire grasses are most prevalent, and these are supplemented by numerous species of panic grasses, affording some grazing while still young and tender. In the longleaf pine belt, near the Gulf, the grasses increase in number of species, the water grasses and the panics being most abundant. The so-called broom sedges are represented by many species in the Gulf States, and in some localities are the prevailing grasses, affording considerable forage They are highly nutritious, and when young are much liked by stock. Broom-sedge pastures, when so grazed as to prevent the growth of the flowering stalks, yield

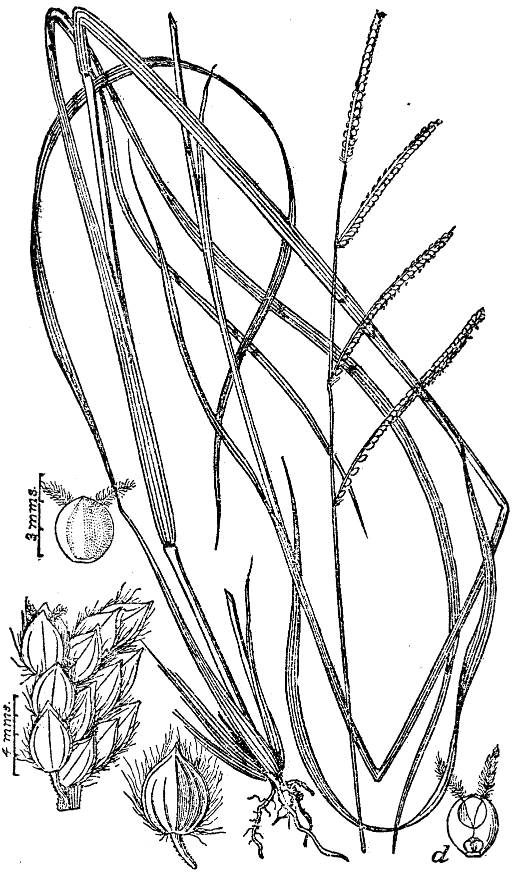

FIG. 78.—Large water grass (*Paspalum dilatatum*)

butter of excellent quality. While the natural growth of these broom grasses may add some value to the native pastures, their abundance is indicative of thin soils or careless management. Up to the present time comparatively little attention has been paid to the pasture plants of the South, and in spite of the great abundance in the variety of grasses of that section, far greater than in the North, the natural pastures are very poor, excepting in a few favored localities. Doubtless the best pasture grass, south of the line of successful growth of blue grass, is Bermuda, but as this is not a native grass it does not come within the scope of this paper.

## TREELESS REGIONS.

### SOUTHWEST.

Texas covers 265,780 square miles of territory, more than three-fourths of which is grazing land, carrying 12,500,000 sheep and cattle. The eastern portion of the State belongs to what has here been termed the wooded region; but the cattle ranges, some of which embrace more than 2,000,000 acres, belong to the treeless region, the native pasture plants of which we will now consider. These plants are nearly all indigenous grasses, of which there are in Texas alone more than 350 species, or one-third of all the species of the United States. Many of these belong to the eastern part of the State, and are identical with those already noted as common in the other Gulf States; but the grasses of the open plains are different in species, and their habits of growth have been modified to meet their environment. The bunch grasses predominate, and these, with a few others noted below, are the prevailing grasses of western Texas, New Mexico, and Arizona, and of the treeless regions which extend northward to the Canadian border.


FIG. 79.—Feather sedge (*Andropogon saccharoides*).

The grazing area of Texas is so large that it may be separated into several sections, according to the characteristic pasture plants of each.

There are two coastal prairies, occupying a comparatively narrow belt along the Gulf, where the dominant grasses are salt grass, salt cedar, a creeping wiry species with many short, bristle-pointed leaves, and a coarse cord grass belonging to the genus Spartina. One of these, called the bunch salt grass, forms great tufts often 4 or 5 feet in diameter and 3 to 4 feet high. Farther away from the coast other grasses appear, the most conspicuous being sedge grasses, and lands covered with the feather sedge (*Andropogon saccharoides*, fig. 79) are known to stockmen as sedge-grass prairies. In certain localities these sedge grasses constitute 75 to 80 per cent of the entire vegetation. Feather sedge seems to be the most important of the range species of Andropogon, and is found in greater or less abundance westward through New Mexico and Arizona and southward into Mexico. By some it is locally known as "cotton grass." A number of the species of the coastal district are similar to those found in the alkali regions of the interior, to which reference will be made further on.

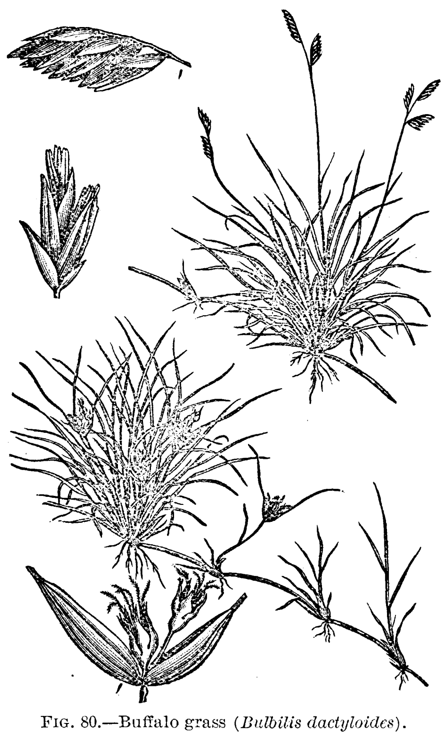

FIG. 80.—Buffalo grass (*Bulbilis dactyloides*).

The cactus plains, or the region between the Colorado River and the Rio Grande, extending northward to near the thirtieth parallel of latitude, belong to the semiarid region, and are covered with a mixture of characteristic grasses, cactus, and chaparral. Here and there are found areas of the true buffalo grass (*Bulbilis dactyloides*, fig. 80), in some places producing fully 75 per cent of the forage. Sand bur (*Cenchrus tribuloides*) is also one of the grasses eaten with relish by cattle on these ranges, and a number of the grama grasses here make their first appearance, marking the transition from arable to pasture lands.

Years ago, before their destruction by overgrazing, the blue stems and sedge grasses, often growing to the height of 4 to 5 feet, were the prevailing grasses over the red prairie region. These are now found only here and there in protected localities, while the needle grasses (species of Aristida, fig. 81, and Stipa) have succeeded them, or their places have been taken by curly mesquite and buffalo grass. These three grasses, together with blue and black gramas, extend westward in increasing abundance and become the prevailing grasses in the region of the Staked Plains. The needle grasses are highly prized by stockmen. They no doubt supply a great deal of pasturage where little else will grow under the existing conditions. They are for the most part low, wiry grasses, which do not root deeply or form a continuous sod. In overgrazed areas they sometimes form fully 50 per cent of the entire grass vegetation. In the Eastern States species of this class are indicative of worn-out soils, and have the local name of poverty grasses.

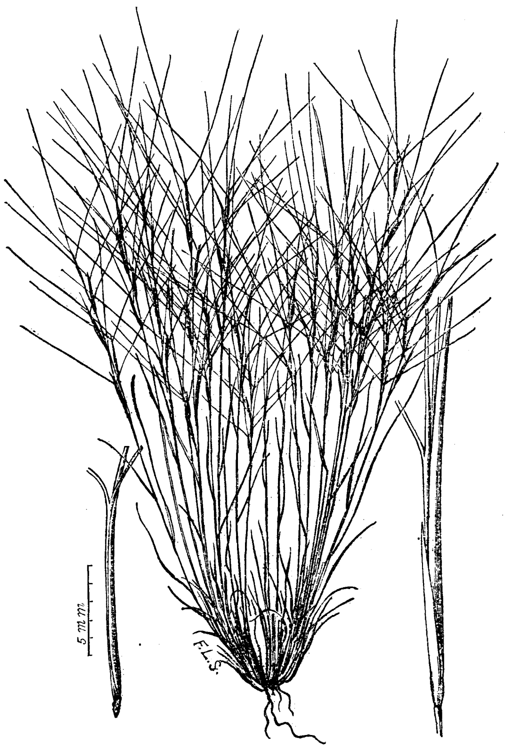

FIG. 81.—Needle grass (*Aristida fendleriana*).

Curly mesquite and the gramas are the turf-forming species of the treeless or semiarid regions of the West. Curly mesquite (fig. 82) is a creeping, fine-leafed perennial having much the same habit of growth as Bermuda, and may be propagated by either seeds or root cuttings. In western Texas and many parts of New Mexico and Arizona this grass is abundant and there is no species of more value for pasturage. Like the gramas, it withstands the trampling of stock, and its endurance of heat and sunlight is equal to that of Bermuda, but it surpasses that species in its adaptability to conditions of excessive drought. This species has been successfully grown from seeds on the trial grounds in Washington City.

Black grama (*Hilaria mutica*) is not infrequent in valley pastures, where it is regarded as one of the best species for winter grazing. Like other grasses in this region, the plant cures on its own roots and retains its highly nutritious qualities through the winter months. In favored localities this grass yields a fair amount of excellent hay.

The gramas, belonging to the genus Bouteloua, comprise a number of species, all valuable pasture plants, and some of them preeminently so. Blue grama (Pl. LXXVIII, fig. 1) is probably the most important of the gramas and has the widest distribution, being found throughout all the treeless region. In Colorado and Montana it is known as buffalo grass, a name which properly belongs to another species. It forms very dense sod and withstands the trampling of cattle to a marked degree. In fact, grazing and more or less trampling seem to be necessary to its most successful growth, although, under favorable conditions of soil and irrigation, it may produce a stand sufficient to make it a productive hay grass. On the prairies and mesas it is everywhere, forming a dense mass of fine and curly leaves near the roots. The flowering stems rise to the height of 6 to 18 inches and bear near their summits two to three one-sided seed heads. This grass is easily propagated by seed, which may be collected without undue expense. Wherever tried in the experimental grounds of the Department of Agriculture its growth has been most satisfactory.

Side-oats grama (*Bouteloua curtipendula*) is another very common species and the most widely distributed of all the true gramas, ranging from the Atlantic States westward to Arizona and extending southward into Mexico. It is a good pasture grass, but does not make so close and even a turf as blue grama. On good soils, however, it makes a taller and more leafy growth, and for this reason is better adapted for hay. The local name of this species is mesquite, or mesquite grass, but the term "side-oats grama" is more applicable, as the seed heads are produced in numerous spikes along one side of the upper portion of the flowering stem.

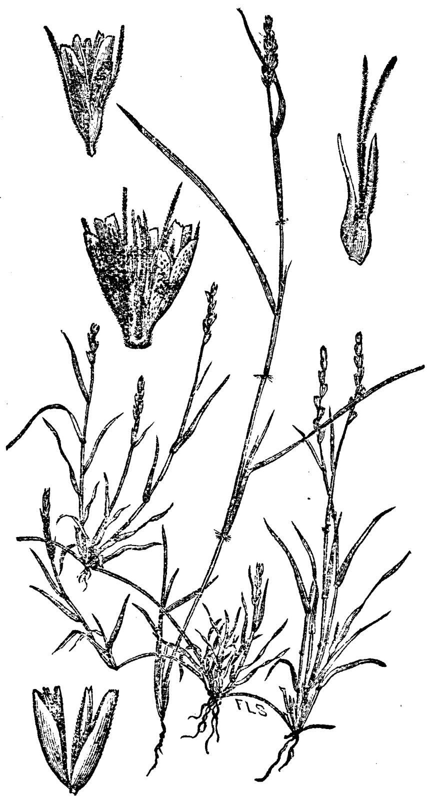

FIG. 82.—Curly mesquite (*Hilaria cenchroides*).

Woolly-foot grama is a species limited to the Southwest, which grows under severe conditions of dryness, and in some places is quite as valuable as any species of the genus. It is common on the Staked Plains of Texas, and extends westward into Arizona and New Mexico. There are a number of other species of Bouteloua which are recognized by stockmen as valuable grazing plants, and among these are low or six-weeks grama, creeping grama, and seed mesquite, or Texas grama. They are all natives of the Southwest States and Territories, and together with those already mentioned are the characteristic pasture plants of that entire section of the country.

Of all the turf-forming species of the treeless region perhaps there is none superior and certainly none more famous than the true buffalo grass (*Bulbilis dactyloides*, fig. 80). This grass ranges from the Canadian border southward to Texas, New Mexico, and Arizona. It is less common in the North, although it frequently covers considerable areas in Nebraska and Colorado; it is especially abundant in western Kansas, and on some of the ranches in Texas it constitutes from 50 to 75 per cent of the grass vegetation. Its habit of growth is almost identical with that of Bermuda grass, having jointed, creeping stems and abundant, more or less curly, leaves, and makes a very dense sod, which seems to improve under the trampling of stock. It is very hardy, as the extent of its natural range indicates, and it appears to be wholly indifferent to rain or drought, being equally at home in the grass plots on the grounds of the Department of Agriculture as on its native plains in Texas.

The bunch grasses do not form so important an element in the pasturage of the cattle ranges of Texas and the Southwestern Territories as they do in the regions farther north. If they existed in former times over considerable areas they have been destroyed by overstocking, and the more hardy grama and mesquite grasses have taken their place. In Arizona and New Mexico and also in Texas we find a few of the wheat grasses and some of the fescues, but less abundantly than in the North. There are, however, in low and more fertile pastures many species of drop seeds, both of Sporobolus and of Muhlenbergia.

Wire grama (*Muhlenbergia porteri*) is common on the dry mesas and table-lands of New Mexico and Arizona. It is a grass of straggling habit of growth with much-branched stems, and furnishes excellent feed for cattle. It does not withstand the continued trampling of cattle, but in good soil it is sufficiently productive to make a fair crop of hay.

Blow-out grass, another species of Muhlenbergia, a tough, wiry plant, ranges from Arizona to Nebraska, growing in the driest situations, where it is at once a good sand binder and a valuable forage plant.

Bearded saccatone (*Muhlenbergia distichophylla*) is a tall, coarse grass, common in the valleys of Arizona and New Mexico. It is much prized as a winter pasture grass, and in season is baled for hay by the Mexicans and Indians, who bring it to market on the backs of donkeys or on carts.

A tall, coarse grass, not infrequent on the bottom lands of the Rio Grande, in similar situations throughout Arizona and New Mexico, is saccatone or maton of the Mexicans (*Sporobolus wrightii*). It is one of the best bunch grasses of the region, and, like bearded grass, is harvested for hay by the Indians and sold in the local markets.

Purple grass (*Pappophorum wrightii*), which is common on the open plains and on the foothills of the mountains, is said to be fully

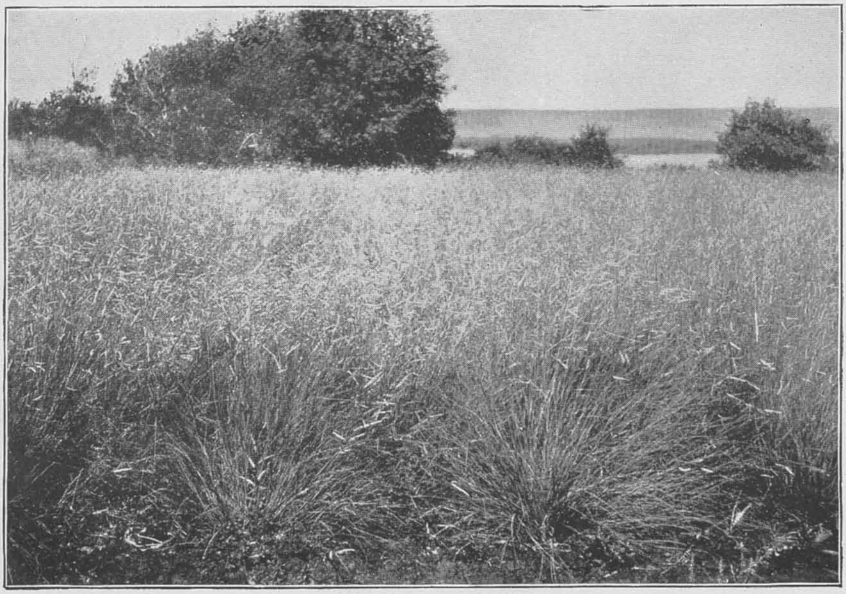

FIG. 1.—BLUE GRAMA (BOUTELOUA OLIGOSTACHYA) AS GROWN IN GRASS STATION AT WALLA WALLA, WASH.

[From photograph.]

FIG. 2.—BUNCH WHEAT GRASS (AGROPYRON DIVERGENS)—NATURAL GROWTH, OREGON.

[From photograph.]


BIG BLUE-STEM (ANDROPOGON FURCATUS).

[From photograph.]

equal to grama or buffalo grass in its nutritive value, and is apparently even more palatable to horses and mules.

Vine mesquite, or, as it is sometimes called in New Mexico, wire grass (*Panicum obtusum*), is one of the valuable range grasses of New Mexico and Arizona, furnishing considerable pasturage in the mesquite districts.

Wiry panic or Arizona cotton grass (*Panicum lachnanthum*) is common in these dry regions, and where abundant furnishes excellent pasturage.

Twisted beard grass (*Andropogon contortus*), which is native throughout the tropical and subtropical regions of both hemispheres, is one of the range grasses of Arizona, affording excellent grazing when young. Its strong, creeping rootstocks and tough, fibrous roots commend it as a soil binder for river banks and slopes subject to wash. There are a number of other species in this region growing in scattered and thin tufts over the foothills and mesas, and which furnish an occasional bite to hungry cattle, but they are not sufficiently important to be noticed in detail.

Big blue stem (*Andropogon furcatus*, Pl. LXXIX) holds an important place in the pastures of eastern Texas, and especially in the great prairie regions just west of the Mississippi River. In the Missouri River region it has been estimated that big blue stem constitutes 40 per cent of the forage resources of that section. In addition to its value as a pasture plant, it makes excellent hay. It does not mature its seeds excepting under most favorable conditions, a fact which has prevented its being more widely known and propagated.

NORTHWEST.

In the treeless regions to the north the pasture grasses change somewhat in their variety, and in Montana, eastern Oregon, and Washington the bunch grasses are the prevailing species. The ranchmen in the Southwest apply the term grama to a number of species, as has already been indicated, so in the Northwest the term "bunch grass" is generally applied to a variety of grasses characterized by their habit of growth. The wheat grasses include a number of these so-called bunch grasses, the chief of which is the wire bunch grass (*Agropyron divergens*, Pl. LXXVIII, fig. 2), which is especially abundant on the bench lands and foothills of eastern Washington and Oregon. It is strictly a dry-land grass, and is one of the best of the bunch grasses for propagation on arid soils. Under favorable conditions it attains a height of 3 feet or more and forms bunches a foot or two in diameter, but ordinarily it is of smaller growth, and furnishes the best winter grazing, being especially valued by ranchmen for this purpose.

Slender wheat grass is another of the bunch grasses common in the prairie regions of Nebraska, Montana, etc., and produces an abundance of soft, leafy stems, 2 to 3 feet high, making it of value not only for winter pastures but for hay. A number of the blue grasses of the treeless areas take on the habit of growth here described and become true bunch grasses, although often they afford the best grazing. Several of the fescues, one of them known as buffalo bunch grass (*Festuca scabrella*), may be classed with these. It is not uncommon on the higher foothills, and oftentimes occupies large areas to the exclusion of other species. It is alike valuable for hay and grazing.

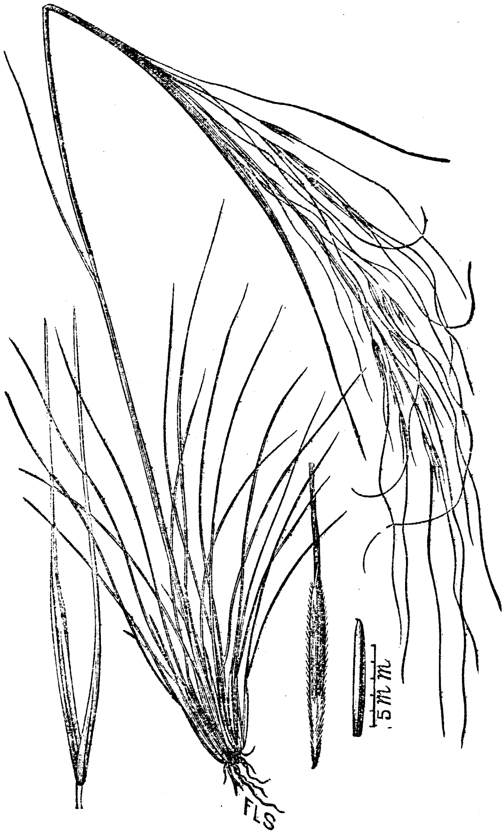

FIG. 83.—Curly needle grass (*Stipa comata*).

In this region a number of the needle grasses, species of Stipa, are abundant, and are important native pasture plants. One, known as feather bunch grass, often attains a height of 2 to 3 feet, and its leafy culm and long seed heads make excellent pasturage; another, and yet more common species, is the curly bunch grass (*Stipa comata*, fig. 83), widely distributed throughout the Northwest, and sufficiently abundant in some localities to be cut for hay. It is an exceedingly valuable pasture grass, and thrives on the dry mesas and bench lands, making it preeminently a dry-land grass.

PACIFIC COAST.

In the treeless regions of California, the native grasses furnish an insignificant part in the maintenance of the bands of sheep and herds of cattle. The vast numbers of the former that have roamed over the native pastures have practically destroyed the indigenous species. The native grasses still remaining are found in places inaccessible to stock or occur in scattered bunches, yielding only a meager supply of forage. On the higher mountains the species are still numerous, numbering many blue grasses and fescues, but on the foothills and lowlands they have nearly disappeared, and foreign species have taken their place. Those remaining are bunch grasses, the most widely distributed being one of the needle grasses, or a species of Stipa. There are several of these Stipas among the California bunch grasses, and all are good forage plants readily eaten by stock.

### DESERT REGION.

The grasses which occur in the strictly desert regions can hardly be classed as pasture grasses, yet they have so often saved roaming bands of cattle from starvation, and have so frequently served to sustain the animals of venturesome travelers, that they deserve mention in this place. The most common are the triple awns or species of Aristida. They are usually low, much-branched, bearded grasses growing in scattered tufts. In other regions they would not be considered of any value, but in the desert, where every bit of vegetation is prized, they are important.

Hare's grass, "Zacate de liebre" (*Aristida californica*), a slender, tufted species, and American triple awn are the most common. One of the gramas (*Bouteloua aristidoides*) is often scattered through the Colorado and Mohave deserts, and is an important grass in those sections. One of the wild ryes (*Elymus condensatus*, Pl. LXXVII, fig. 2), a tall bunch grass, which grows in most arid regions of the West, contributes a share to the fodder plants, while a native prairie grass, *Elymus sitanion*, growing in rocky soils under extremely arid conditions, is a valuable grass in these deserts.

Probably the most valuable of the desert grasses is Galleta (*Hilaria rigida*). It has coarse, branching woody stems 1 to 2 feet high or more, and grows in great clumps, its appearance suggesting some of the dwarf bamboos. It is regarded as a valuable variety for pack animals, which may traverse these regions, and without this grass miners and prospectors would find great difficulty in crossing the arid mountain and desert regions of the Southwest, since scarcely any other forage plants occur in the region occupied by Galleta. It grows abundantly on the open plains or in the desert canyons, and seems to delight in pure sands.

### PASTURE PLANTS OF THE ALKALI SOILS.

In close relation with the deserts of our country are the areas of so-called alkali soils; in fact, the soils of the deserts are usually strongly impregnated with the alkali salts, and the desert forage plants are for the most part identical with those common to the alkali regions. There are a number of native grasses which may be called salt-loving species, and their presence is a sure indication of an alkaline soil. One of the most characteristic of these in the regions of the Southwest and California is fine-topped salt grass (*Sporobolus airoides*, fig. 84). This is one of the native tussock or bunch grasses, and is found throughout the desert lands and regions of the Southwest, extending northward to Nebraska and Montana. It is one of the important grasses of the Red Desert region of Wyoming, and in spite of its harsh foliage and woody culms is usually kept well eaten down by stock.

Rough-leafed salt grass (*Sporobolus asperifolius*) is common throughout the region in question, and will grow on the strongest alkaline lands. It is a low, spreading species, with comparatively soft leaves and fine tops, and furnishes a moderate amount of grazing in many localities. One of the wheat grasses already referred to, *Agropyron tenerum*, is common in the deserts of Wyoming and the Northwest, and in rare cases forms a close uniform growth that yields as much per acre as an average field of timothy. It is probably one of the best pasture and hay grasses of light soils, and its cultivation has been attended with success. Other species of wheat grasses, including the Western wheat grass, are occasionally found on alkali lands, as are several of the wild rye grasses, including great bunch grass (*Elymus condensatus*) and *Elymus simplex*. The latter has comparatively low growth, but delights in strong alkali lands.

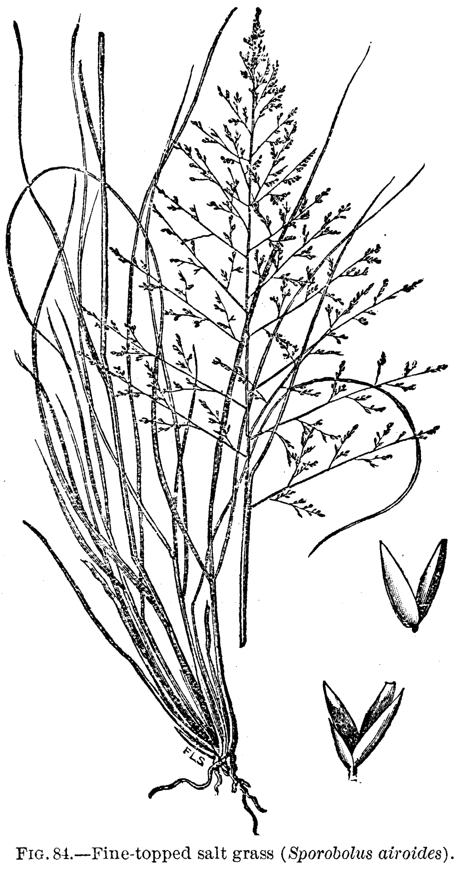


FIG. 84.—Fine-topped salt grass (*Sporobolus airoides*).

Indian millet (*Oryzopsis cuspidata*, fig. 85) is found in desert places where the soil is more or less alkaline, and is often seen growing in the drifting sands of the desert. It ranges from New Mexico and southern California northward to the Canadian line. All kinds of stock relish it, and the seed heads appear to be specially palatable to horses.

The most widely distributed and most abundant of all the grasses of alkali soils is *Distichlis maritima*, or what is widely known as salt grass. This grass is not confined to the salt lands of the interior, but occurs on the salt marshes of the coast from Maine to Texas and on the west from British Columbia southward. It will thrive even in ground heavily impregnated with alkali and other salts, and where nearly all other vegetation would perish. In the interior it ranges from Montana southward to Texas and Arizona, and although much inferior in quality to the better pasture grasses of the East, in the region where it occurs it is often esteemed very highly. It will form a good sod, and, under favorable conditions, it makes a sufficient growth to produce a good crop of hay. It is probably the most abundant species in the Rio Grande Valley, in Texas, New Mexico, and in the valleys westward to the Pacific Ocean. Its presence is regarded as an infallible sign of water near the surface, a fact taken advantage of by prospectors and miners. In the dry regions the grass is valuable for the pasture it furnishes near the springs that serve as watering places for stock on the open range.

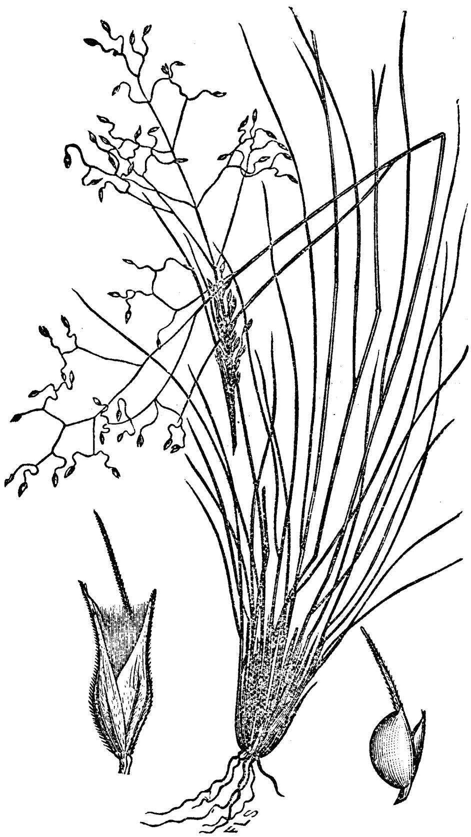

FIG. 85.—Indian millet (*Oryzopsis cuspidata*).

### CONCLUSION.

This paper has been limited to a brief consideration of the more important of the native pasture plants belonging to the grass family. Doubtless some species quite as valuable as others which have been mentioned have been omitted, and it is certainly true that there are a great many pasture plants in all the regions which have been covered belonging to other families of the plant kingdom. This is especially true in the wooded areas of the East and the alkali plains in the interior. In the former and in the wooded regions of the Rocky Mountains are found many valuable forage plants, some of which have come to be well recognized. They belong chiefly to the legume family, and are represented by the vetches, wild lupines, and clovers. In a country containing 1,000 species of indigenous grasses, more than 60 native clovers, 40 vetches, and as many beggar weeds, with more than 100 wild beans and lupines, it would be impossible to consider or even enumerate them all within the limits of this paper. Many pages might be filled with an account of the legumes alone. Our many native salt bushes and other forage plants indigenous to the alkali soils of the West have already been noted in the Yearbook of the Department for 1898. These salt bushes furnish winter pasturage for vast herds of cattle and sheep in the alkali regions of the West, and their position among our forage crops is no longer questioned.

Such is the abundance of our pasture plants that heretofore little thought has been taken for their preservation or improvement. Pastures have been managed as though the grasses could take care of themselves, and the ranges have been overstocked and continuously grazed, with the apparent idea that the forage supply was inexhaustible. These methods have resulted in disaster in many places, and among the greatest problems now before the Department of Agriculture is that of discovering some method by which the cattle ranges may be restored to their former productiveness and the worn-out pastures successfully renovated. The formation, care, and management of pastures; the best methods of restoring the grasses on the cattle ranges of the West; pasture plants for the great areas of alkali lands in the interior; winter grazing for the South and Southwest; and drought-resistant grasses for arid sections, are forage problems of national importance, and their solution lies in the thorough knowledge of the habits and special qualities of our native pasture plants, the extent of which is barely more than indicated in this paper.

# DAIRY PRODUCTS AT THE PARIS EXPOSITION OF 1900.

By Henry E. Alvord,[1]

*Chief of the Dairy Division, Bureau of Animal Industry.*

## Countries Exhibiting and Character of Exhibits.

The dairy industry was given a prominent place in the agricultural section of the Universal Exposition at Paris in the year 1900. The following countries were represented in the exhibits in this class, and the relative extent and importance of their contributions were approximately in the order stated, the figures in parentheses indicating the number of separate entries of all kinds: France (800), Switzerland (160), United States (152), Russia (100), Belgium (60), Denmark (35), Holland (32), Germany (30), Great Britain (28), Canada (?), Italy (21), Portugal (13), French Colonies (12), Bulgaria (10), Mexico (9), Luxembourg, Hungary, Spain, Austria, Greece, and the Republic of San Marino. Sweden is the notable omission from the list. As hereafter explained, some countries exhibited almost exclusively a single kind of product, while others contributed more or less variety. Every conceivable kind of dairy product was on exhibition, from one source or another.

This branch of the exhibit was divided into two distinct parts: First, the imperishable articles, which were included in the permanent exhibits of the various countries in the "Palace of Agriculture" at the Champ de Mars; and, second, the perishable products, milk, cream, butter, and cheese, which were contributed to three special and temporary "concours," or shows, held in the months of May, July, and September, each lasting one week.

The first part comprised, as a rule, such things as condensed milk in sealed packages, sterilized milk in bottles, and butter and cheese in air-tight cans; also models of butter and cheese in various forms and commercial packages, with pictures, maps, charts, statistics, etc., illustrating the condition of the industry, production, varieties, and markets. The United States was the only country which attempted to maintain a continuous exhibit of fresh dairy products. This was made possible by having a large display refrigerator, which was one of the

[1] Major Alvord was detailed from the Department of Agriculture as expert for the United States Paris Commission, in charge of the dairy exhibit of the United States at the exposition of 1900, and was also a member and vice-president of the international jury for class 40, "Dairy products," etc.—Ed.

most prominent features of the American agricultural section, and by the efforts of this Department, which, in connection with its experimental exports for the year, furnished constant supplies of fresh products. There were thus to be seen throughout the exposition sample commercial packages of various styles of the finest butter and cheese from creameries, farms, and factories in all parts of this country. Fresh arrivals enabled renewals and changes to be made fortnightly, and these frequently included natural milk and cream from noted American dairies. In the French section two local companies maintained dairy lunch booths, with constant fresh supplies of milk and cream, and a few others kept pasteurized and sterilized milk on exhibition. There were also daily demonstrations, during the greater part of the exposition, of the manufacture of butter and Gruyère cheese, by syndicates of French cooperative creameries and cheese factories. But there were no collections or general displays of fresh dairy products in the exposition proper from France or from any foreign country, save the United States.

### Location of the Temporary Shows of Dairy Products.

The three temporary shows of dairy products were held in the inclosure of the exposition annex in the park of Vincennes. This was 7 or 8 miles up the Seine from the main exposition, outside the city limits. It required a full hour to make the journey from any part of the regular exposition to this annex, and the location and accommodations were alike unsuited to the purpose. A dairy pavilion was constructed by erecting a skeleton frame and covering it with canvas. This temporary shelter failed to keep out storms on the one hand, and on the other hand it became a veritable oven on a bright summer day. In this framed tent the delicate dairy products were exposed day after day, upon open tables, with no protection whatever. Conditions could not have been much worse. To this distant and inconvenient place the products had to be moved from the storage and regular agricultural exhibit quarters at the Champ de Mars, passing two sets of customs and octroi (or city tax) officials en route, occasioning much delay and annoyance, and necessitating a Government escort, which had to be paid for. It was actually more trouble and expense to move the dairy products from the Palace of Agriculture out to Vincennes Park, guard them there, and move them back again, than it was to get them from New York to Paris; the products were also subjected to very much more exposure, deterioration, and injury. The location and conditions were as unsatisfactory to French exhibitors as to those from other countries. It was bad enough for local products, which had not been subjected to refrigeration or to any sufficient substitute for preservation; for products brought hundreds and even thousands of miles, and which had been subjected to refrigeration during a considerable period in transit, the situation was well-nigh disastrous. A vigorous official protest was made in April on behalf of the United States dairy exhibit, but to no purpose. Unfortunately, the circumstances were not appreciated by the United States Commission, and the subject was not pressed upon the exposition authorities as it should have been.

A grave mistake was made in thus locating and providing for the dairy shows. Aside from dissatisfaction to exhibitors, the attendance of visitors amounted to nothing, and as public exhibitions and object lessons they were failures. In this respect the temporary fruit and flower shows, held in the fine horticultural buildings and the grand Salle des Fêtes, which were constantly crowded with visitors, were an instructive contrast. The Salle des Fêtes, which stood empty and useless most of the time, was a very large and magnificent hall, and occupied the center of the immense building known as the Palace of Agriculture. The hall was surrounded by the agricultural exhibits of all nations. On either side were food displays of France and those of other countries, all under the same roof and including the permanent dairy exhibits. This hall was the ideal location for the dairy shows, and was well suited to the purpose. It was quite large enough, light, and yet well shaded, with ample mechanical contrivances for ventilation and for cooling the atmosphere, and with a floor which could be kept clean. Several artificial ice machines were in daily operation within a few rods. Why the dairy shows were not held in the Salle des Fêtes was not apparent. At this place they would have been convenient for all exhibitors, amid tasteful, attractive, suitable, and favorable surroundings, and they would unquestionably have proved to be popular and instructive exhibitions.

## THE JURIES AND THE MANNER OF MAKING AWARDS.

All dairy products were entered in Group VII, "Agriculture," and in class 40, "Food products of animal origin." The international jury of award for this class was composed of sixteen Frenchmen, two members each from Great Britain (one for Canada) and Switzerland, and one each from Denmark, Germany, Holland, Portugal, Russia, and the United States. The jury organized by the election as president of a member of the Senate of France who is president of the National Society for Encouragement of the Dairy Industry; as vice-president, the member from the United States; as reporter, a French cheese manufacturer with extensive dairy connections in central and southern France; and as secretary, one of the largest and best-known cheese merchants of Paris. Among the members were officers of some of the principal milk-supply companies of Paris, the heads of the two largest butter factories in France, the director of the union of Roquefort cheese makers, representatives of the leading Paris houses for dairy products and of the Gruyère syndicates of the Jura region, the secretary of the national dairy association, the director (or principal) of the National Dairy School of France, three dairy officials of National Governments (other than France), and two managers of large milk-condensing establishments. As thus constituted and organized, the jury was already rather too large (twenty-six), but its members represented collectively a thorough knowledge of the dairy industry in all its branches and broad experience in the products and markets of the world. It was a strong body, quite capable of performing well the duties devolving upon it. To this jury, however, "the administration" added as "expert assistants" and "degustateurs," or tasters, twelve men from the active butter and cheese trade of Paris. With two or three exceptions, these additional aids were persons who knew the Paris markets, but nothing else. This needless addition made the jury too large for efficiency and materially weakened its work. In a good many cases very meritorious products were marked down and the awards degraded through the influence of these assistants, because of not meeting the Parisian standards of taste. Decisions are thus accounted for which were not in accordance with the actual merits of the articles exhibited, and which would not have come from a smaller and more deliberate body of competent men.

The jury met almost daily during the last half of June and the first week in July, and examined with care, first in a body and then by committees of specialists, the permanent dairy exhibits of the various countries. The examination of the perishable products of the temporary shows began on May 24, July 26, and September 20, respectively, continuing two or three days in each case. An office room was set apart for the use of the jury in the Exposition Palace of Agriculture, and on several occasions meetings were held in a quieter and more comfortable apartment, courteously provided at the Ministry of Agriculture, rue de Varenne. After the examinations and scoring by individual members and committees, the full jury met, received reports, discussed the questions arising, and decided upon the awards. All the proceedings were of course conducted in French and the records and reports made in that language. Under instructions from the exposition administration, every exhibit deemed worthy of any notice was assigned a mark upon a scale of 1 to 25, and reported upon solely by the mark. But it was understood that the marks carried awards upon the following basis: 1 to 5, inclusive, honorable mention; 6 to 10, diploma of bronze medal grade; 11 to 15, diploma of silver medal; 16 to 20, diploma of gold medal; 21 to 25, diploma of the grand prize of honor.

Although the reports of committees and subsections upon individual exhibits were generally accepted by the full jury and the decisions confirmed, the awards of gold medals were frequently challenged and discussed. This was always the case with collective exhibits, and the award of a grand prize was made only upon a formal vote at a general meeting. At the closing sessions of the jury in September, when the final decisions were made and the official report prepared, the president was absent and the vice-president from the United States was in the chair. All reports from the class juries were submitted for revision to a higher or group jury, composed of the officers of the class juries. The awards of the jury for class 40 were approved by the jury for Group VII, with two or three minor exceptions not affecting the United States, and recommended for confirmation. The group jury took special action in making up the list of collaborators, to whom awards were made individually in recognition of their personal services in connection with certain exhibits or the work of invention, progress, or improvement thereby represented. The awards were finally passed upon by a large and specially selected superior jury, including several members from the United States. The work of this jury was mainly pro forma, certainly so as to all awards in class 40.

The articles in the permanent exhibit were reported upon before the end of June, and received no further attention from the jury. Regulations provided that French exhibitors at the temporary shows must exhibit at all three, and their rating would be the average of their three scores or marks. But exhibitors of products from other countries were permitted to enter at one or more of the three shows, and awards were made in the foreign sections at each of these exhibitions. This was a just and at the same time a generous provision on the part of the exposition authorities. While no single French exhibitor could thus receive more than one award upon similar entries at the three shows, the same foreign exhibitor might receive three awards, possibly, for example, with one cheese or three cheeses from the same lot. But the United States exhibit at the temporary shows was managed so as to avoid repetitions, and, as far as possible, entries were from a different set of exhibitors at each show. The entries in the permanent exhibit afforded opportunity for a fourth set from this country.

Under these circumstances there was no actual competition among exhibits or exhibitors. Every entry was inspected and marked, or was supposed to be, upon its own merits, regardless of any other exhibit. It was a system of grading rather than competing. Thus, for example, in the display of any one country, several lots of butter might each receive a silver medal; although they might be marked 12, 15, 13, 11, and 14, no two alike, all would receive the same diploma, being placed in the silver medal grade.

## The Exhibits from the United States.

### THE COLLECTION AND THE TOTAL AWARDS.

Great care was taken by officers of the Department of Agriculture to have different parts of the country represented and to exhibit only products of the highest quality. The assistance of State dairy associations was obtained in selecting farms and factories to be invited to exhibit. These invitations were generally extended to those who had been prize takers in large exhibitions in this country; yet few offers of exhibits voluntarily made were declined, where the quality of the products was satisfactory. All butter and cheese intended for the exposition was brought together periodically at a cold-storage warehouse in New York, there critically inspected, and only such as reached a fixed standard of quality was forwarded to Paris. The standard was necessarily changed somewhat from month to month. Products found unsuited for export were sold in New York on account of the contributors. This culling process resulted in maintaining a high average quality in the United States dairy exhibit at Paris, and in securing some award for nearly every entry from this country. Products were included from 20 States, as widely separated as Maine, Georgia, Minnesota, and California, and from 105 different contributors. Butter was exhibited from the 4 States above named, as well as 12 others; cheese from California, Nebraska, Wisconsin, Michigan, Ohio, New York, and Vermont; condensed milk from Atlantic and Pacific States and others between; and fresh milk and cream from Illinois, New Jersey, and New York.

A full list of the awards to dairy products from the United States will be found in the Appendix to this Yearbook. Including the collaborators and the collective awards, as in the case of the State of New York and of this Department, the prizes won were as follows: Grand prizes, 6; gold medals, 38; silver medals, 52; bronze medals, 28—total, 124.

### THE DEPARTMENT'S ARRANGEMENTS FOR TRANSPORTATION AND CARE OF EXHIBITS.

No such result would have been possible but for the complete and efficient arrangements for transportation, care in Paris, and exhibition, made by the officers of this Department in conjunction with those of the United States Exposition Commission. Portable refrigerators were made in the form of chests, with capacity for 50 to 100 pounds of butter, and a water-tight ice box holding 40 or 50 pounds. In these the products were packed at stores of the Merchants' Refrigerating Company (New York), the ice boxes filled at the latest hour possible, and the chests quickly transferred to the cold room on the ships. Ocean refrigeration was secured through the courtesy of the

Schwarzschild & Sulzberger Beef Company of New York, lessee of the cold compartments on the American line of steamships from New York to Southampton. Upon notification when a shipment was ready, this company left space in an export beef box to be occupied by the exhibit material. Upon landing at Southampton, England, the same company provided cold storage for the dairy chests at the docks until they could be placed securely upon the steamboat to Havre. No refrigerated transportation was available beyond Southampton, but the trip to Havre was always made in the night, the chests transferred at Havre in the early morning (more than a mile across the city) to shady sheds at the railroad, then loaded and moved to Paris by a fast freight train in the night. Arriving at Southampton on Wednesday or Thursday, the products usually reached Paris on Saturday morning, the twelfth day after loading at New York. Special acknowledgment for courteous and efficient assistance all through the season, in this important matter of transportation, is due to the companies above named, as also to the officials of the London and Southampton Railway Company, which controlled the docks at Southampton and the boats to Havre, and to Messrs. Langstaff & Co., its agents at Havre, for expeditious forwarding.

The greatest difficulties were encountered at Paris, owing to the inadequate railway terminal facilities, the slowness of customs officers, and the exposition regulations, which were needlessly obstructive. Although the goods reached an express freight station within the city and little more than a mile from the United States agricultural exhibit before daylight, it was often late in the afternoon before delivery was made at the latter place, even with the assistance of the transfer facilities of the American Express Company. Meanwhile the chests were unavoidably exposed to sun and heat and their refrigerator construction alone saved the contents. When these chests were opened on the exhibit space to transfer their contents to the display refrigerator, sometimes on the thirteenth day after packing, more or less of the New York ice was found unmelted in the boxes. The same refrigerator chests were used in transferring the products from the Champ de Mars to Vincennes for the special shows. They were also kept under the benches in the Vincennes tent during the shows and a daily supply of ice obtained, so that those exhibits specially needing this protection were cold-stored every night during the temporary show, and sometimes cooled for an hour during the day, being thus kept in very presentable form, despite most unfavorable exhibit conditions. The United States was the only country having any such facilities for carrying, storing, and protecting its products, and the dairy refrigerator chests elicited almost as much interest and commendation as the milk, butter, and cheese from this country, which they preserved in such excellent show condition.

## Discussion of the Exhibits and the Awards.

Referring to the awards for dairy exhibits, in class 40, some comments seem desirable. Two awards of the highest distinction, the Grand Prix d'Honneur, are especially notable.

### THE GRAND PRIZES.

The first was won by Samuel Haugdahl, of New Sweden, Minn., for a tub of butter at the special show in May. This was the only instance during the entire exposition in which the highest honor was awarded to an individual exhibitor for a dairy product. The same award was made in several cases to collective displays, but to no other single exhibit or exhibitor. The United States and the successful maker may thus justly claim to have received what was virtually the grand sweepstakes, or very highest award for a single lot of butter shown at the World's Fair of 1900. It may be added that this decision was made by the French members of the jury while the American member was absent serving upon the subjury on cheese, and without his solicitation; it was solely upon the merits of the article. Later, some members of the jury seemed to think this action too exceptional, and revision was proposed, but the majority sustained the original award, which was duly confirmed.

The second grand prize was awarded to the Borden's Condensed Milk Company of New York for its display of the "Eagle," "Peerless," and other brands of condensed milk in the permanent exhibit. This was the only article or exhibit of this character which received the highest award. But it should be stated that two, if not three, similar exhibits were "hors concours" (not competing), because representatives of these companies were members of the jury. If this is any qualification of the award, it is also a compliment, for it shows that the company which has succeeded the originator of this product and the parent factory of the industry, is recognized by its strongest foreign competitors as producing an article which commands their highest commendation. No award for condensed milk could have been higher in any event, for the jury assigned the maximum mark of 25 to this exhibit, which was virtually a declaration of perfection.

The other four grand prizes were awarded to the U. S. Department of Agriculture for the collective exhibits by the Dairy Division, Bureau of Animal Industry—one for each of the special shows and one for the permanent exhibit. No other country except France received so many of these highest honors. At the July show the jury directed (in the absence of the writer) that the following be added to the official recommendation for the United States award of the Grand Prix: "With the felicitations of the jury upon the uniform excellence of the products and the admirable manner in which they are exhibited."

## MILK AND CREAM.

A part of the United States exhibit which was most creditable in itself and attracted much attention was the small collection of natural milk and cream in commercial form. Three enterprising dairies engaged in city milk supply upon modern methods contributed milk and cream in small quantities every two or three weeks, so that this was an almost continuous feature of the exhibit. Regular delivery bottles (quarts, pints, and half pints) were used, the only extra precautions being to use two paper caps instead of one, and to cover these with paraffin so as to absolutely exclude air. In a few instances, owing to undue exposure en route, the milk reached Paris in a slightly acid condition. Generally, it not only arrived in good condition, but remained sweet for some days afterwards, being quite sound on the fifteenth, eighteenth, and sometimes on the twentieth day after leaving the cow. Foreign visitors and expert milk dealers on the jury were hard to convince that nothing but "cleanliness and cold" were used to preserve these products. Full descriptions, with photographs and affidavits, to explain the sanitary conditions under which this milk was produced and prepared, were supplemented by exhaustive examinations and tests by an eminent French chemist. When finally satisfied as to the honesty of these exhibits, all three were promptly awarded gold medals. The Briarcliff Farm Dairy of Westchester County, N. Y., the Fairfield Dairy of Essex County, N. J., and the Clover Farm Dairy of De Kalb County, Ill., were thus justly honored. But numerous other dairies in this country, conducted upon sanitary principles, might have done quite as well, and fortunately the number of these sources of supply of natural pure milk is rapidly increasing. Exhibits were also made of American milk pasteurized and sterilized, but there was nothing about these to attract particular attention.

No other country except France attempted to show natural milk and cream. There were numerous exhibits of pasteurized and sterilized milk from Austria, Belgium, Germany, and Switzerland, as well as France, which were creditable enough in their way, but by no means deserving of the substantial recognition they received at the hands of the jury. The French exhibits of natural milk and cream were in striking contrast with those from the United States. At the July show there was not a single one of these local exhibits which was fit to use the day after reaching the grounds, and even in the moderate temperature of the May and September shows the French products were all sour on the second or third day. But there were the natural products from America, just as they would be delivered to consumers in New York and Chicago, still perfectly sweet, a fortnight after being bottled and after a summer journey of 3,000 or 4,000 miles.

The United States exhibit of condensed milk and "evaporated cream" was large and excellent in quality, comparing favorably with like products from other countries. There were nine exhibitors and a great variety of brands. The jury gave these goods a critical examination and, besides the grand prize already mentioned, awarded 8 medals, 2 of gold and 3 each of silver and bronze.

### BUTTER.

UNITED STATES.—During the season several lots of the very best butter of the United States were displayed at the exposition, and in nearly all cases they were placed on exhibit without being perceptibly impaired in quality, although of course they were two or three weeks old. Experienced and competent judges would unquestionably have pronounced these butters equal on the average to any in the world, and certainly to any shown at Paris, but they were not appreciated by the exposition jury and did not receive their deserts. With a single exception they were salted butter, and that is probably enough to account for the result. All the best butter of Europe is without salt, sold and generally consumed within a few days from the time it is made. In the Paris markets no butter for table use is salted, and the "expert tasters" on the jury knew only the Paris markets. In those markets the poor and faulty butter is salted and sold for cooking and confectionery. Any butter that was salted meant to these jurors an inferior article, full of faults which salt was used to hide, and fit only for the baker or the second-rate cook. This experience and prejudice could not be overcome. The one unsalted exhibit was promptly given a gold medal, and some of the lightly salted lots fared pretty well. Occasionally an exhibit had such conspicuous merits that recognition could not be denied, but, as a rule, if the salt was distinctly perceptible to the taste it required much urging and the assurance of its standing at home, to secure any award whatever for such butter. To illustrate: Ten gold medals were awarded to United States butters. They were all light salted except one. These ten lots were carefully judged and scored before leaving New York, within a fortnight of the Paris judgment, and their average score was 95 points. Ten other lots, with more salt, were given 5 silver and 5 bronze medals; the average score of these ten lots in New York a fortnight earlier was 96.5 points. In the first lot only two scored above 95; in the second lot three scored 97 and two 98. It must be admitted, however, that the jury experts were educating themselves by their exposition work, and they improved as time passed. At the May show the United States received 1 gold medal on 12 butter exhibits; at the July show 2 gold medals on 26 butter exhibits, and at the September show 6 gold medals on 27 butter exhibits. This shows a decided gain. The American butter at the July show, which won only 2 gold medals, was made in June, and was as a lot decidedly superior to that shown in September, which was made in August, and yet won 6 gold medals.

In all there were 56 exhibitors of butter from this country, and they won 64 prizes, namely: 1 Grand Prix, 10 medals of gold, 32 of silver, and 22 of bronze.

FRANCE.—The only country whose butter exhibit was at all comparable with that of America was France; 230 French exhibitors had butter at all three of the shows. Among these there were 37 awards of gold medals, or 16 per cent of the total exhibits. The 10 gold medals for the United States constituted 15½ per cent of its total exhibits, and counting the 1 grand prize as an additional medal, gives 17 per cent, or a greater proportion of first-class awards for this country than for France. The United States stands very well by this comparison. It must be admitted, however, that the French butter exhibit as a whole labored under two disadvantages: First, as already stated, every exhibitor was obliged to show butter three times, and his award was upon his average merit; second, the French section was open to everyone who chose to make entries, and there was much poor butter shown, while the United States sent only selected lots.

As to the different sections of France, the region of Normandy led with 84 exhibits, 23 of which, or 27 per cent, won gold medals. This was nearly all from the district of Isigny, in the Department of Calvados. Brittany and French Flanders came next, with 20 exhibits and 5 gold medals, or 25 per cent. It is all farm-dairy butter in this northern and northwestern region. The creameries, mainly cooperative, are in the western part of the country, especially in the departments of Charente and Deux-Sèvres; from this district there were 72 exhibits, of which only 7 per cent won gold medals. It thus appears that, according to French judgment, the dairy butter of that country averages better than the creamery butter; but it was noted that the highest mark of all given to French butter was to a cooperative creamery at Saint-Christophe-sur-Roc, in Deux-Sèvres. All the rest of France together made only about 50 entries of butter, and these won 4 gold medals. There were in addition, however, awards of the grand prize to some of the largest and finest collections of French butter exhibited—the Agricultural Society of Bayeux, the Syndicate of Dairy Farmers of Isigny (those both in Calvados), and the Central Association of Cooperative Creameries of Charente and Poitou.

Very nearly all of the French butter was exhibited in what are called "mottes," being the usual form in which it is sent to market. These are lumps, wrapped in white cloth, cotton or linen, and placed in cheap baskets, usually without covers and of the shape of a peach basket or a small butter tub. In warm weather the lumps of butter are smaller than the baskets and surrounded and covered by one-half inch or more of long wheat straw. For exhibit, the "mottes" are emptied from the baskets and placed on the show benches with the small ends up. The cloth is then turned back to expose the butter for examination and tasting. In a few cases boxes of different sizes and shapes were used instead of baskets, but if the butter was in mass and wrapped in cloth it was still called a "motte." (See Pl. LXXX.) The "mottes" varied in size from 8 to 20 pounds. There were only ten exhibits of French butter by the makers in the form of prints or blocks and but two lots of salted butter in this entire section, but several Paris retail merchants exhibited butter in prints and rolls of a quarter pound and upward, very neatly wrapped and labeled, and also a variety of convenient small packages. Among the latter the local favorites were earthen bowls or crocks with covers, holding 1 or 2 pounds, and little square, white baskets in which lumps of like size were nicely packed. The French market unit for butter is the "kilo," which is $2\frac{1}{5}$ pounds, but the "livre," or (large) pound, is still more or less in use in Paris and the popular measure all through the country districts.

It can be readily understood that butter exhibited in such form, the lumps irregular in shape and size and wrapped in different ways and different cloths, presents anything but an attractive appearance. This butter has never been cold or hard and, although when exposed it "stands up" better than if it had been refrigerated, high temperature affects it in time. In hot weather the lumps become soft and misshapen, the cloths oily, and under the Vincennes conditions, without protective covering for days, all becomes dusty. Thus, these entire exhibits of butter at the temporary shows soon had an unfinished, unsightly, neglected aspect, or very bad show form. But it was the custom of the country and all seemed satisfied. Very little artificial coloring is used in France; none during the pasture season; and the dairy cows of the country are not strong in the color attribute. A very light yellow was therefore the prevailing shade in these exhibits. Freshly made from cream, either sweet or very slightly acid, the flavor was negative—mild, flat, insipid. But that is what the Paris butter market likes, no distinct flavor. Now and then a butter was found in which a higher degree of cream acidity had been developed, resulting in a more attractive (?) flavor, but these lots were not often prize winners. Good grain is often sadly lacking in this French butter; some of it is waxy and much salvey and decidedly overworked; but it has a very fine texture, is free from buttermilk, and keeps well. Mottles are almost unknown; it is butter without salt. Although carrying a full allowance of water, this is so thoroughly and evenly incorporated that the butter appears to be very dry.

France is said to possess 6,500,000 cows, besides 10,000,000 sheep and goats, which also contribute largely to the country's supply of dairy products; 2,200,000,000 gallons is the reported annual milk

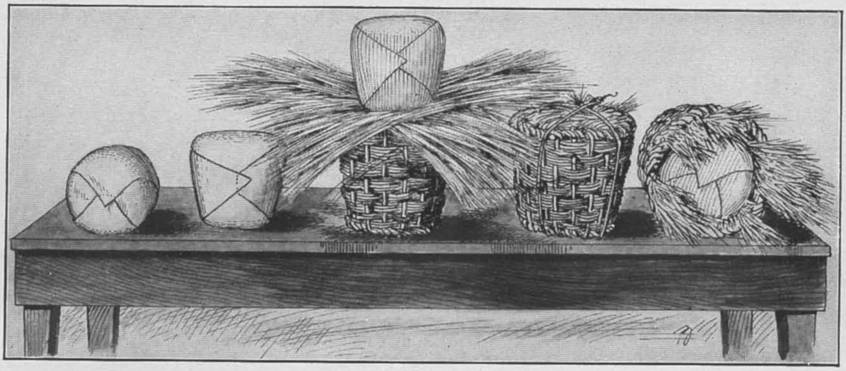

FIG. 1.—THE FRENCH "MOTTE" OF BUTTER, WITH BASKET.

FIG. 2.—AUCTION SALE OF BUTTER (IN MOTTES) AT PARIS MARKET.

product. Assuming that the product of the smaller animals only makes up for the cows which are not really dairy stock, the yearly average product of milk per cow is just about 400 gallons, or 3,470 pounds. The annual production of butter in France is believed to be 400,000,000 pounds. The regions of greatest production are well indicated by the entries of the exposition. By far the largest part of the butter in France is made on farms, in the households of the cow owners, and the primitive system of churning the whole milk, while it is quite sweet, is still much in vogue, particularly in Brittany. Creameries have been introduced within twenty years. The first cooperative establishment was that of Chaillé (Surgères), organized in 1888, with 88 patrons (or "Sociétaires"), and producing that year about 65,000 pounds of butter. There were 100 cooperative creameries in this same region in 1900, with 50,000 patrons, owning 120,000 cows and providing over 16,000,000 pounds of butter. In addition, there are nearly as many more creameries, most of them proprietary, about half in the west of France and the rest scattered through other parts of the country. The Association of the Creameries of Charente and Poitou, already mentioned as receiving a grand prize, operated the working creamery in the permanent exhibition at Champ de Mars during the exposition. Butter was made daily, and the most improved creamery fittings and appliances of French manufacture were thus shown in practical use. The process of butter making pursued there did not differ materially from that ordinarily in vogue in America, but it required rather more than twice as much labor (attendants) as would be used in this country to accomplish the same results. France imports from 10,000,000 to 15,000,000 pounds of butter annually and exports from 50,000,000 to 70,000,000 pounds. England is the largest buyer, but large quantities are sent to the West Indies and South America; Brazil takes 4,000,000 pounds a year, and this, of course, is salted and in sealed packages.

Switzerland.—The Swiss entries of butter were very disappointing. There were sixteen lots, most of them in mottes and baskets, neater in finish and general appearance than the French, but inferior in quality. Some was in prints and a few lots were salted. Only one gold medal was awarded and that went to the instructor and buttermaker at the Federal Dairy School at Rütti-Zollikoffen. Four received silver medals. In general, this butter was poorly made and unpleasant in flavor. There was one lot of "process" butter, claimed to be "sterilized" and well adapted to export, but it was a very poor article.

Germany.—The German butter was still worse; this was shown in the permanent exhibit and examined by the jury in June. The samples of butter in this exhibit were so very bad as to be entitled to no prizes whatever. The conditions were very unfavorable at the Palace of Agriculture, where no refrigeration was provided, but this could not alone account for the very poor quality of this butter. The French members of the jury nevertheless gave several awards so absurdly high as to be actually so many gratuities. Germany should certainly have made a better butter exhibit at Paris, if any. Dairying is receiving much attention in that country. There are good dairy schools and nearly 2,000 creameries, many of which have been recently organized and are operated upon modern methods.

HOLLAND.—Holland sent butter to the May and September shows. There were ten entries and in a variety of forms: Small kiels or kegs, holding 10 to 20 pounds; blued tin cans of 5 to 10 pounds; whitewood oblong boxes with sliding covers, holding about 10 pounds of butter packed solid, and similar boxes containing the butter in pound bars, each in a wrapper or paper case, ten or twelve of these to a box; also sealed cans of several sizes for export. But none of this butter was good. No gold medals were awarded, and five lots barely got into the silver grade by generous treatment. Considering the perfection to which cheese making has been carried in Holland, and the high quality of the cheese shown by that country, it is remarkable that the butter was no better; especially so, since the most prominent exhibits were made under the auspices of the Dairy Society of Frise, a province in the north of Holland, where the Danish methods have been adopted. The first cooperative creamery was established at the village of Warga in the year 1886, and there are now 45 such establishments in the province. Some of these are quite large, and they collectively receive 400,000,000 pounds of milk a year. They are organized in a strong association to advance their common interests, and have adopted the trade-mark *Nedraw* for their products; the headquarters are at Leewarden. The factories make cheese at times, as well as butter, and it is probable that this largely accounts for the poor quality of the latter product as shown at Paris.

BELGIUM.—Belgium made quite an extensive display of butter at the September show, there being over fifty entries. It was generally in the form of bricks and prints, from one-fourth to 1 pound weights, packed in boxes holding 3, 5, 8, and 10 pounds. The prints were neatly wrapped in parchment paper, and were often in cartons or paper boxes. The average quality of this butter was good without being superior. The jury criticised the Belgian butter very closely and was not generous in making awards to that country. Four gold medals were given and a dozen of silver. The dairy districts of Belgium constitute a source of supply so convenient to Paris markets as to afford an unpleasantly sharp rivalry to French dairymen.

LUXEMBOURG.—The Grand Duchy of Luxembourg made a single collective exhibit representing the general syndicate of cooperative creameries in that country. This butter appeared at the May and

September shows, in 1-pound bricks and 10-pound boxes, well made and a good article, and was accompanied by an interesting description, with map and illustrations, showing how the dairying of the country had been recently revolutionized. Under Government supervision, the farm dairying has been replaced within seven years by a well-distributed system of cooperative creameries. These now number 66, with 3,143 patrons, and jointly produce several hundred tons a year. This is fresh butter, made from sweet centrifugal cream. There seemed to be no disposition to encourage or commend this admirable piece of dairy progress. The collective exhibit was as well worthy of the highest honor as others which received it, but received only a silver medal at first, which was later reluctantly raised to gold.

Russia.—At the May exhibit the entries from Russia were unexpectedly large and fine. The butter was shown in casks or firkins made of birch or a similar wood and containing about 100 pounds each. Of these, there were 40 from as many different creameries, besides some smaller packages and butter in sealed cans. Nearly all of this butter was salted and evidently colored (some too much), but it was otherwise very uniform and of high quality, although not the best. It was, however, quite a revelation that various parts of Russia are producing such good butter and in such quantity. As very little of it is consumed at home, the new supply is appearing in the large markets of the world and offered at prices so low as to give concern to producers in other countries. The creameries represented by this interesting display, which very justly received a number of good awards and the grand prize collectively, are many of them cooperative, and are located in different portions of Russia and Siberia. All have been established within thirty years, and most of them during the last ten or fifteen years. One in Wologda (begun in 1871) receives 1,400,000 pounds of milk and produces 60,000 pounds of butter annually; another, in Novgorod (1884), 4,000,000 pounds milk and over 160,000 pounds butter; another, in Tobolsk, Siberia (1897), 3,500,000 pounds milk and 135,000 pounds butter. These are average examples. There is one ten years old in Wologda twice as large as that in Novgorod. In the year 1871 the first dairy school in Russia was founded by the government of Twer, and two others soon followed by the governments of Riasau and Toula. At this time melted butter only was exported from Russia, and Turkey was almost the only market. Very rapid progress has been made since in the organization of creameries, the diffusion of dairy instruction, the quantity of butter produced, and improvement in its average quality. The work is supervised and assisted by the Central Government. Western Siberia has been the region latest developed and in which progress has been most rapid. There are now in that region 334 creameries and in European Russia about 1,000; many of these are new and very small. (See Pl.

LXXXI, fig. 1.) The product of these establishments differs greatly in quality, but as the result of Government inspections of the export butter, it is reported that 15 per cent is rated excellent, 40 per cent satisfactory, and the remainder of mediocre quality or lower. The annual export of butter from Russia is now about 25,000,000 pounds. Rather more than one-fourth of this goes to Germany, a little less to England, about one-sixth to Finland, and the rest (or most of it) to Turkey and Austria. The portion to Finland is really in transit, being exported again, mainly to Denmark. The London market alone takes 5,000,000 pounds of Russian butter a year, imported either directly or by way of Denmark. (See Pl. LXXXI, fig. 2.) Having made a decided "hit" at the May exhibit, Russia did not appear again. The difficulties in transportation from Moscow to Paris during the warm weather of July and September were too great an obstacle.

DENMARK.—Denmark, which was expected to be an important contributor all through the season, did not appear in the entries of butter until September. Then a most excellent display was made, not large, but admirably shown and of high average quality. There were three collective exhibits. The first was from the Association of Cooperative Creameries for the Export of Danish Butter, headquarters at Esbjerg. This consisted of 10 baskets of 20 pounds each, and 10 boxes each containing 2 dozen 1-pound blocks. The baskets or mottes were of unsalted butter, suited to the Paris market; the packages were neater than those common in France, with covers and good linings. The boxes were prepared for the London trade, the butter half salted, and each pound in a separate labeled wrapper. The second lot was from another association of cooperative creameries of Denmark, with headquarters at Kolding—10 baskets, or mottes, of the 10-pound size, and 20 little kiels, or kegs, each holding 20 pounds. This butter was salted and half salted, of the remarkable uniformity for which the best Danish export butter is famous, and of a quality unexcelled in the entire exhibit. The third entry was made by Carl Holbeck, of Copenhagen, a merchant who does an exporting business of over $2,000,000 a year, and consisted of samples of his supplies from different makers. There were a dozen mottes of fresh butter of 20 pounds each, shown in French style, wrapped in cloth; London boxes with 1-pound and 2-pound rolls or blocks, lightly salted, and salt butter in sealed tins for distant markets. All of this Danish butter had been made within ten days of the time it was judged, and the display was under the supervision of Bernard Böggild, late secretary of the Royal Agricultural Society of Denmark and now dairy expert and adviser for that body. The butter was submitted to the jury as three collections; the first and third lots were awarded gold medals and the second the grand prize. The Danish commission also received the

FIG. 1.—A RUSSIAN COOPERATIVE CREAMERY IN SIBERIA.

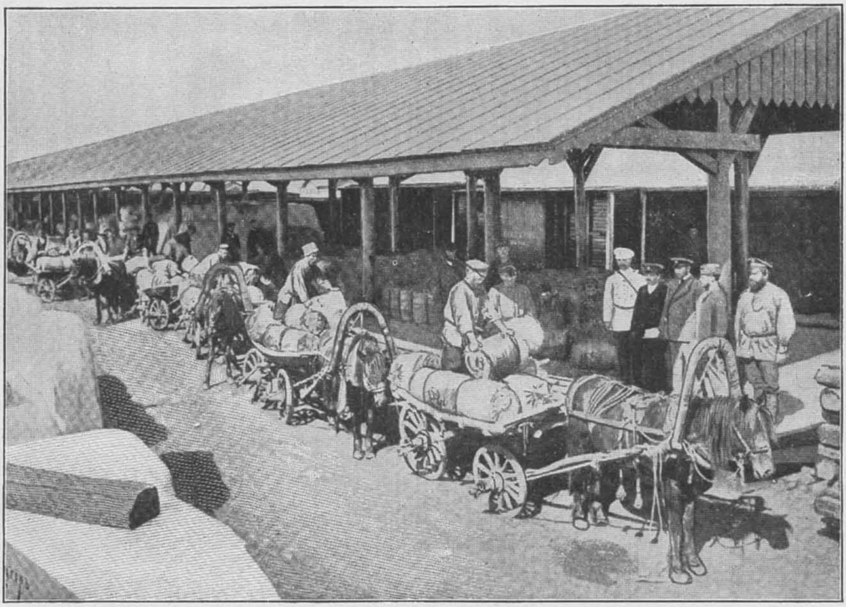

FIG. 2.—SHIPPING RUSSIAN BUTTER TO LONDON FROM SIBERIA.

highest honor for the exhibit as a whole. Denmark is noted for the rapid development of its dairying during recent years and for the present extent and prosperous condition of that industry. The first cooperative creamery in that country was established in 1882, and the immense export trade in butter, almost all of its creamery product, has been built up since that time. Much had been done, however, to improve dairying during the decade preceding 1882. The number of milch cows in 1871 was 807,000; in 1881 there were 850,000, and now there are about 1,100,000. The export of butter, which was 30,000,000 pounds in 1871 and only 53,000,000 pounds in 1887, has now become 170,000,000 pounds. There are 1,200 cooperative creameries and 300 operated on the proprietary plan. The quality of the butter product has been equally advanced. The Danish Government takes an active part in the work and closely watches the exports to see that the butter sent abroad is absolutely pure and of a standard which will enhance the reputation of this commodity. The result is that Danish butter stands at the very head of the markets in Great Britain, and the latter country takes over 95 per cent of all exported by the former. The butter of Denmark in sealed cans also holds the highest reputation in all the remote and nonproductive markets of the world.

## CHEESE.

United States.—The exhibitors of cheese from the United States fared much better at the Paris Exposition than those who sent butter. In all, 38 entries were made for 34 different exhibitors, and 38 medals were won—19 gold, 16 silver, and 3 bronze. Thus, every exhibit received an award, and as the 3 bronze medals were assigned to persons who also received something higher, at another time, every American exhibitor of cheese received a medal of either gold or silver. And 50 per cent of these exhibits won gold medals. The largest and best display of cheese was at the July show; despite the torrid conditions and some "huffing" of the cheese, which could not be avoided, 17 entries were awarded 12 gold medals and 5 silver medals. This is a very satisfactory record all through.

It is not difficult to account for the cheese exhibit of this country being more successful than the butter. The article was better understood by the examining jury. Cheese of the general American factory, or Cheddar type, although little sold in Paris, is by no means unknown in French markets. The experienced merchants and makers of pressed cheese who were members of the jury and whose opinions decided these awards, were fairly familiar with the American commodity. It is only just to record that the member for Canada was a potent factor in securing these results. Very consequential was the fact that there were no other exhibits of cheese, and especially none of French origin, of the same general class, and with which these from the States could be unfavorably compared by any peculiar fancy of French taste. The writer feels bound to add his individual opinion, that, while all this American cheese was excellent of its kind and well deserved the awards made, the average quality of the butter shown from the United States, and its condition when exhibited, was equally good, perhaps even more closely culled, and upon its actual merits, as well as comparatively, its harvest of awards should have been as rich as that obtained for the cheese.

There were no foreign exhibits of cheese with which those from this country could be well compared as to either quality or prizes won. The closest resemblance occurred in the cheese shown by Canada and Great Britain.

CANADA.—There were admirable displays of Canadian cheese in the permanent exhibit and also at the September show. At the latter, the "yearlings" shown, both white and colored, could not be excelled. But the Canadian commissioner preferred to have these exhibits judged collectively; consequently the cheese were not scored singly, but only a few samples examined, and the collections awarded the Grand Prix, the same as the collective exhibits by the United States.

GREAT BRITAIN.—The British Dairy Farmers' Association entered a case of cheese in the permanent exhibit which contained one to three samples each of Cheddar, Cheshire, Leicester, and Stilton; this collection was awarded a gold medal, being on a par with the New York State collection in the same exhibit.

MEXICO.—The half dozen entries from Mexico were none of them very good, but three were interesting and deemed worthy of silver medals. The government of the State of Zacatecas sent large loaf-shaped cheese, two or three years old, quite hard and something like the Parmesan, but richer, with a clean flavor, and sharp. From the territory of Lower California, there were peculiar little cheese, thin, flat, and white, like a soda cracker, and said to be a great local favorite; from the State of Mexico, a brick-shaped article, about 9 by 12 inches and 4 inches thick, the rind yellow with red streaks, and the interior of cream color, hard, and full of small eyes or shot holes. All three of these exhibits were given silver medals.

BULGARIA.—Bulgaria exhibited a cheese called Kachkaval, in size and style like an English dairy, but quite white, and made of sheep's milk; the exhibitor is said to be the maker of over 100,000 of these per year, which are largely sent to Constantinople, and there sold at about 30 cents a pound. From Varbovo (Widdin), in the same country, was shown a moist, soft curd, snow white, made from the whole milk of sheep, not pressed, and preserved in brine; this was a year old and quite good. At its home this is an important food product, and sells at the very low rate of 3 cents a pound. A gold medal and one of silver rewarded these two exhibits.

Hungary.—Hungary made what was decidedly the most artistic and attractive display in the entire agricultural section. Two entries of cheese received the same awards as those of Bulgaria. The first was a soft kind, like Camembert, small, round, well made, packed in tin foil, and strong enough to satisfy the most highly cultivated taste. This was the usual product of a herd of 200 cows. The other was from sheep's milk, white, granular, and packed in little wooden firkins holding from 2 to 4 pounds. It has a taste and odor all its own.

Greece.—The sole dairy exhibit by Greece was a cheese made from the milk of goats at a school of agriculture in Thessaly. It was similar in size and form to a large Gouda, although in character more like an English dairy; was ten months old, an excellent article, very creditable to the maker, and deserving the gold medal awarded.

Portugal.—Portugal made a large number of entries in the catalogue, but only eight lots of cheese were actually shown. Most of these were of the Parmesan character, but nearly all small, from 1 to 4 pounds weight. There were a few from the milk of sheep and goats, some soft, like the Brie, and others very small, white, dry, and hard. These eight lots all got medals of different grades, two being of gold and hardly merited.

Italy.—Italy made over 30 entries of cheese and had 13 lots on exhibition. Parmesan was naturally the leading variety; these cheese were two, three, and four years old, coated with linseed oil and animal charcoal, and rubbed till they shone like polished ebony; they were round and flat, 4 or 5 inches thick, and large enough to weigh from 50 to 80 pounds. They came from Parma, Milan, and Reggio'-Emilia. Five lots were shown in exceptionally good order, with fine flavor, and each was awarded a gold medal. Other kinds were made from sheep's milk, some spherical, but roughly formed, white, and dry; some in skins, of bottle or tenpin shape, also very white, but part of them covered with tin foil. These were the variety called Caciocavallo; they were a year old, and well kept but strong in taste. A large collection sent by the chamber of commerce of Naples received a gold medal, which seemed a needlessly high prize. Another lot from Sardinia, decidedly better, four years old, well made and well kept, received only a silver medal. The latter were flat, 8 or 10 inches in diameter, and 2 or 3 inches thick, also from sheep's milk. An exhibit similar to the last, but not nearly so good, came from the sheep of the Roman campagna; the bronze medal awarded was quite enough. Curiously, no Gorgonzola was shown in the Italian section.

Germany.—The cheese shown by Germany was nearly all in the permanent exhibit and most of it was in sealed tins. It was mainly of the Limburger, Backstein, and Munster varieties, with others of the same general, loud-smelling type, and there were also some like the

French Brie and Camembert. Despite the protests of a minority, these inferior lots of cheese were awarded half a dozen gold medals and more of silver, where bronze would have been good enough for any of the exhibits.

Russia.—The Russian exhibit at the May show contained over 100 cheese, but none of a local or national character. They all represented the recent dairy development of the country, and were made in imitation of foreign products, Cheddar, Cheshire, Emmenthal, Gruyère, Edam, Limburger, Backstein, and Sapsago. The imitations were clever and some of the cheese very good. As a whole, it was a creditable show for a comparatively new dairy region, but the average quality was not high and the awards were generous. A few of the 43 factories represented in this exhibit were established prior to 1870, but most of them are only ten to fifteen years old. They are located in various parts of Russia, and a number of them are cooperative.

Holland.—The cheese exhibit from Holland was confined to the noted hard-pressed varieties of that country, Edam and Gouda, and the products were of high average quality. Besides a fair permanent exhibit, this country had a very good display at the May show, and in September one of the best of all. The Edams, some a year old, were admirably made, of dense body, excellent consistency, and finely developed flavor. All were spherical in form, nearly the same size, and weighed about 3½ pounds. A few were shown uncolored and a few bright yellow, but the characteristic crimson exterior prevailed, and some were covered with tin foil, while others were in spherical tin cases, sealed, for export to hot climates. The Goudas varied greatly in size, from 1 pound to 20 pounds, but all were of regulation form, flat, with edges rounded in a half circle, and the thickness from a third to a fourth of the diameter. They may be called a plain cheese with a mild, pleasant favor, and in both body and taste, somewhere between the Cheddar and Edam. They are very generally colored a bright chrome yellow on the outside. At the September show every one of the 10 entries of Holland cheese received either a silver or gold medal, most of them the latter, and there were 2 grand prizes awarded, 1 for a fine collection by one of the largest of the Dutch exporting houses and 1 for the entire Holland exhibit, butter included.

Switzerland.—Switzerland, which had not previously been conspicuous at the dairy shows, made an exhibition of cheese in September which was one of the most notable of the season. It was so large that a special pavilion had to be constructed for it, by the side of the dairy building at Vincennes Park. The cheese was entered in four sections: First, the Emmenthal variety, 109 entries; second, the Gruyère, 26 entries; third, the Sbrinz, 9 entries; and fourth, 13 entries of other varieties, including the Tilsit, imitations of the French Brie, Camembert, and Roquefort, the Sapsago, or Schabzieger, and a few

FIG. 1.—EMMENTHAL CHEESE FACTORY IN SWITZERLAND.

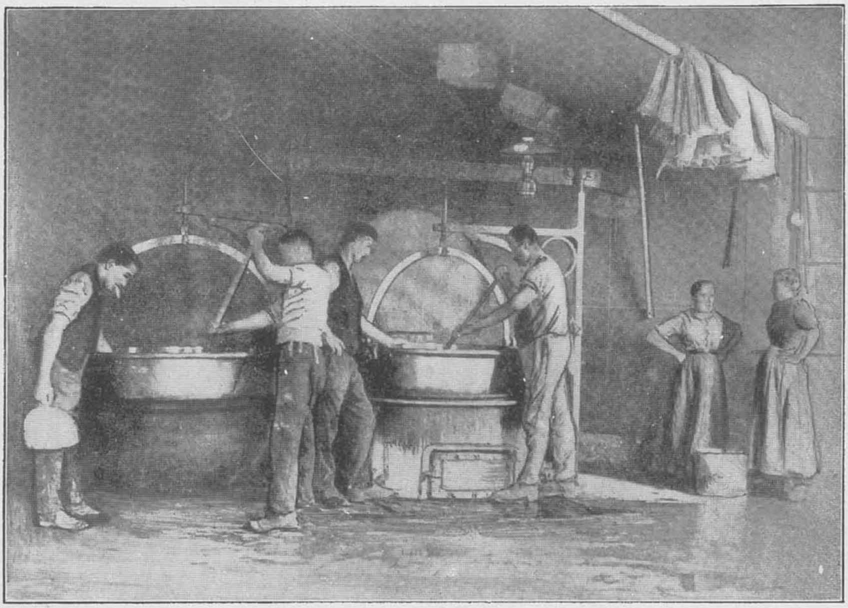

FIG. 2.—COOKING THE CURD FOR EMMENTHAL CHEESE.

[Both of the above figures apply equally to the Gruyère cheese industry in the Jura Mountain region of France.]

Yearbook U S. Dept of Agriculture, 1900.

FIG. 1.—FROM THE MOUNTAINS—CARRYING MILK TO THE CHEESE FACTORY IN SWITZERLAND.

FIG. 2.—IN THE HAMLET—CARRYING MILK TO THE CHEESE FACTORY IN SWITZERLAND.

not so well known, named Baumont, Romadour, and Tomme. In all cases there were at least two cheese to an entry, so that the display included considerably over 300 specimens. The main feature was the collection of more than 200 of the great "cartwheel" style of Emmenthal cheese, best known in America under the name of "Gruyère" or "Schwitzer-käse." These are round, flat cheese, from 3 to 5 feet in diameter, and 5 to 8 inches thick, weighing from 150 to 250, and sometimes 300 pounds. They are finely made, with a workmanlike finish, the body yellowish-white, elastic and dense, fine-grained, but with "eyes" or spherical holes distributed throughout the cheese. In the best-made specimens, these eyes are uniform in size, three-eighths to one-half inch in diameter, and very evenly distributed, showing a skillful control of the fermentation or gas formation. When cut, the meat of the cheese has a dull, smooth appearance, but the concave surfaces of the eyes are bright and shiny. The flavor is distinct and characteristic, mild at first, but developing in strength with the age and treatment of the cheese. Each specimen was exhibited on a smooth board of its own size, which greatly assisted the attendants in dextrously turning these great cheese over every day. Ten different Swiss cantons exhibited this variety. Berne seems to be the center of this industry, as it had 63 entries, and every one of them was from a cooperative factory. (See Pls. LXXXII and LXXXIII.) These cheese were all selected from the commercial stocks of the factories, and were not bored or tested until submitted to the jury; the high average quality can be judged from the award of 41 gold medals and about as many of silver, among 109 exhibitors. The Gruyère variety was shown by 4 cantons, all being made in single dairies, or farm-dairy cheese. This cheese is of the same type as the Emmenthal, and except for being smaller in size, with a rather different finish, the novice could not distinguish between the two. But the Gruyère is far less uniform in quality and is considered inferior, as shown by the fact that none of these exhibits received a gold medal and only five of them silver medals. The Sbrinz cheese, also called Spalenkase, is simply a Swiss Parmesan. They were equal in quality to the Italian originals and of even better finish. Several exhibitors showed cheese of all ages, from six months to five years. One medal of gold and 8 of silver were awarded to the 9 exhibitors. Collectively, this was a most creditable section of the Swiss exhibit; nearly all the entries were from the canton of Unterwald. The rest of the Swiss cheese display was not remarkable, although the Sarrazin variety was of interest. This was made of cows' milk, but in appearance was a true Roquefort. It has not the exact flavor, yet was quite good; but the French jury looked upon it as a counterfeit and gave it no credit. The same maker from Sarraz, near Lausanne, exhibited two cheese of the same shape and size, called Tomme, made from skim milk and sold at 8 and 10 cents a pound; one had the characteristic Roquefort mold and the other none. The entire cheese exhibit of Switzerland was given a grand prize, and the honor was well merited.

Cheese making is the most important branch of Swiss dairying and an important item in the commerce of the country. From 1850 to 1860 the average annual export of cheese from Switzerland was 12,000,000 pounds; this trade reached a maximum of 60,000,000 pounds in 1886 and 1887, and was over 50,000,000 pounds in 1899, worth about $8,000,000. The principal importing countries, and something of the variation of the trade, are shown in the following table:

*Exports of cheese from Switzerland.*

| Country to which exported. | Maximum. | | Minimum. | |
|---|---|---|---|---|
| | Pounds. | Year. | Pounds. | Year. |
| France[1] | 20,000,000 | 1886 | 11,000,000 | 1893 |
| Italy | 18,000,000 | 1887 | 6,000,000 | 1899 |
| Germany | 13,000,000 | 1899 | 9,000,000 | 1895 |
| United States | 7,200,000 | 1899 | 3,300,000 | 1888 |

[1] France, 15,000,000 pounds in 1899.

It thus appears that the exports to France and Italy are declining, while those to Germany and the United States are steadily increasing. Emmenthaler cheese constituted all of this trade.

FRANCE.—France herself had a display of cheese less imposing than that of Switzerland and with fewer exhibitors, but it included a much greater variety. The entries numbered about 150 and the exhibits were good at all the shows. Besides individual entries by the makers, and a few collective exhibits by some group of local dairies and factories, there were several elaborate and quite artistic displays by leading cheese merchants of Paris. The latter showed remarkable variety in form and character, including numerous kinds peculiar to France, and which never enter into general commerce. The cheese of this country may be naturally divided into two great classes, the pressed kinds, with hard rinds, and those not pressed and soft. The former embrace the Gruyère, Cantal, Roquefort, and Port Salut. The manufacture of the first-named variety is confined to the eastern part of France, the Jura mountain region adjoining the Swiss frontier. It has been a leading industry for centuries in the section known as the Franche-Comté, but especially in the departments of Jura, Doubs, and Upper Savoy. The production of Gruyère in this region amounts to 44,000,000 pounds per year. This type of cheese is very old, and it bore the name "Vachelin" until the beginning of the nineteenth century; then importations to France began from the neighboring cantons of Switzerland under the name Gruyère, which was soon adopted by the French. (The present Gruyère is probably a slight improvement upon the original Vachelin, but with no material change in form, size, and character; the Emmenthal is a newer form, developed from the Gruyère, larger, more open in body, and with some modification of manufacture.) One notable feature of the cheese making of the French Jura region is that it has long been carried on under a system of local societies, known as "fruitières," which are founded upon cooperation among the milk producers. (See Plate LXXXII.) These associations have authentic historical record from the thirteenth century, and although it was much later before common factories were built for their work the "Franche-Comté" can probably justly claim the oldest continuous system of cooperative cheese making in the world. The cows of this country have been for centuries the red-and-white race known by the name of Montbéliarde, a regional type, if not a breed. A syndicate of cheese factories and fruitières, numbering 600 subscribers, under the lead of the Agricultural Society of the Department of Doubs, with headquarters at Besançon, maintained a working factory in the French section of the permanent exposition, where one Gruyère cheese was made daily as an illustration of the modern processes. This exhibit received a grand prize, as did also the collection of cheese at the temporary shows, made under the same auspices. The Cantal is the next largest cheese made in France, and is the production of the mountainous districts of the departments of Cantal, Auvergne, and others, in the center of the country. This cheese is usually made in the shape of a barrel, and often 2 feet high and 18 inches in greatest diameter. It is well pressed, but the curd is not cooked, and the body, while quite dense, is soft and very white. The exterior is dressed so as to have a white, chalky look. The cheese is not of high quality, but it sells at a low price, comparatively, and is fairly popular. The samples exhibited received moderate awards.

Roquefort cheese is perhaps more widely known than any other, although not entering general commerce in as large quantity as the Gruyère. It is of very ancient origin, having been carried from France to the markets of Rome in the first centuries of the Christian era; its manufacture in the eleventh century, substantially as to-day, is well authenticated, and the historical record is complete to the present time. The center of this industry has been the same from the first, the little village of Roquefort, situated upon the precipitous face of limestone cliffs, 2,000 feet above the river Soulzon, in what is now the Department of Aveyron, in the central part of southern France. This cheese is made from the milk of sheep, mainly the Larzac breed, which are grazed by the tens of thousands upon the hills and mountains in Aveyron and adjoining departments, and valued mainly as dairy animals. Although the curd is separated from the whey and put into the usual form by slight pressing in molds on the peasant farms and at factories throughout this region, the cheese is nearly all taken to Roquefort for salting, trimming, and curing. The curing is accomplished in the famous natural caves in the mountain behind the village and the large vaults lately built in connection with and supplementary to these caverns. The cool air currents, even temperature, and peculiar atmosphere of these caves, cause the slow ripening and the development of greenish blue mold, which give this cheese its characteristic appearance and flavor. The cheese are round, about 8 inches in diameter, and 4 inches thick, the average weight being 4½ pounds. When cured, the body of the cheese is quite soft and an ivory white, except as it is "marbled" by the growth of mold. The finishing and marketing of the Roquefort product is now mainly in the hands of two large companies, having abundant capital, the total output being over 3,000,000 cheeses annually, or about 6,000 tons. While Paris is naturally the chief market, cheese is shipped directly from Roquefort to all parts of the world. The two principal Sociétées des Caves, or manufacturing companies, made elaborate and attractive displays at the exposition, not only of their products but of large models and pictures of the Roquefort cliffs and caverns, cheese-making appliances, etc., and each was awarded the grand prize. The Port-Salut is the only other pressed cheese which appeared in the French exhibit. This originated about thirty years ago at the Abbey of the same name, in the Department of Mayenne. It has been copied elsewhere, and is now made in numerous places, especially at the industrial establishments of religious orders. One of the popular forms takes the name of La Trappe from its place of manufacture in Calvados. These cheese are of cooked curd, quickly made, hard pressed, in various sizes, but the usual shape is that of a flat, thin Gouda. One size noted was 10 inches in diameter and 3 inches thick, and another 6 by 2 inches. The odor and flavor are both peculiar and not pleasant on first acquaintance. The silver medals awarded indicated that this class of cheese has its friends in France. A cheese similar to the Edam is made in the west of France, and another firm, pressed cheese in the Pyrenees Mountains; but neither of these appeared at the exposition.

The soft, unpressed cheeses of France, called "fromages à pâte molle" and "fromages affinés," are given many different names, but they have a general resemblance and vary only in minor points, shape, style, and the age of ripeness, or decomposition, to which they are carried. The oldest and best known varieties are the Brie, Camembert, and Coulommiers. The first was known at the beginning of the fifteenth century, the second is something more than a hundred years old, and the third is of more recent origin. Other popular kinds are Pont l'Évêque, Géromé, Livarot, Langres, Maroilles, and Mont d'Or. All of these soft cheese are shaped in molds of different sizes and shapes, and afterwards cured resting upon mats, usually of straw.

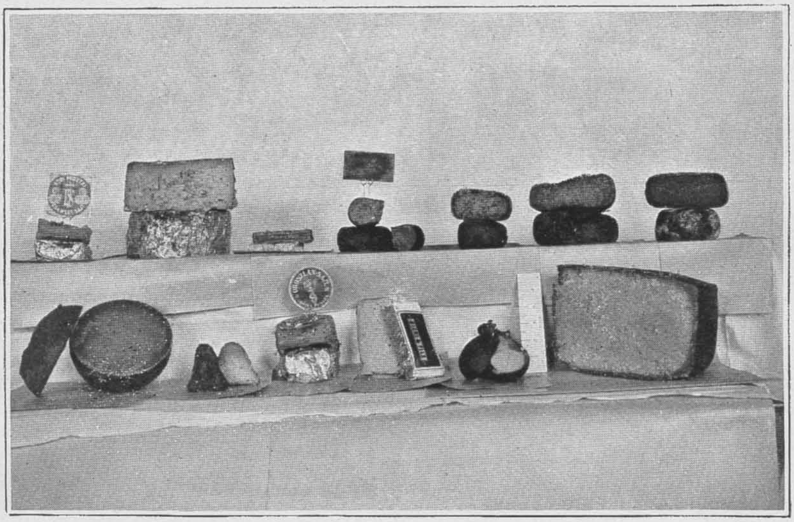

FIG. 1.—VARIETIES OF EUROPEAN CHEESE.

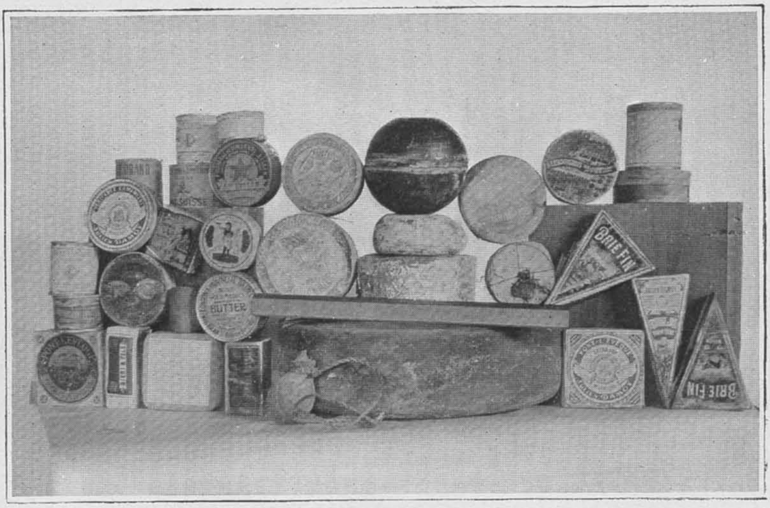


FIG. 2.—VARIETIES OF EUROPEAN CHEESE.

They form a slight, tender covering or rind, and the interior, generally yellowish-white, is, in the earlier stages, of the firmness of freshly-made butter. Slight differences in preparation, time and temperature, and in the atmospheric conditions during curing, produce the characteristics of the several varieties. Some of these are kept until quite old before connoisseurs consider them ready to eat. Another section of the soft French cheeses are those made to be eaten while quite fresh, and some without salt, including the Neufchâtel, Bondons, Gervais, Malakoffs, cream, and double cream. All of the above were exhibited by numerous makers at the temporary shows, and the best of their kinds received gold and silver medals. The grand prize was awarded to the Godefroy factory, known as the Laiterie d'Orbiquet, in Calvados, for its display of several varieties of cheese, especially Camembert, and to the Pommel establishment in Seine-Inférieure, for its Fromage Crème. Simply to show the habit of multiplying names, the following are given, copied from the cards of French exhibitors placed upon cheese which differed in no essential particular from one or another of those already named: Metun, St. Florentin, Levroux, Poitiers, Montbrison, Rigottes, Troyes, St. Patrice, Septmoncet, St. Nectaire, Deauville, Fourme d'Ambert, Champenois, and Gex. But these included two or three made of the milk of sheep or goats, and thus entitled to special names. (See Pl. LXXXIV.)

Cheese making is a very important branch of the dairy industry of France. It is estimated that the annual product of cheese of all kinds reaches 300,000,000 pounds, or just about the same as in the United States. To this must be added from 25,000,000 to 35,000,000 pounds annually imported from Switzerland, Germany, Belgium, Holland, and Italy, less 13,000,000 or 14,000,000 pounds exported yearly from France. An annual consumption of about 8 pounds of cheese per capita is thus provided for the French people.

### The Exhibit of By-products.

Besides the standard products of the dairy, the United States exhibit contained an illustrative display of the methods in which the by-products of dairying are utilized. From skim milk are made dry casein and albumen, and milk sugar is extracted from whey. The plain casein is adapted to food purposes in a form called "egg powder," but very much more used in making a sizing for paper and a water-mixed paint. The sugar of milk and albumen are of application in pharmacy and have other commercial uses. All the solids of milk, other than fat, are also extracted in a powdered, soluble, and digestible form under the name of Nutrium, which is in much demand for adding to the quality and food value of baking products. This method of utilizing skim milk seems destined to become extensive and a very valuable adjunct to dairying. The largest and most varied exhibit of this character was contributed by the W. A. Hall Chemical Company of Vermont, and was awarded a gold medal. The National Nutrient Company of Jersey City contributed to both the permanent and temporary exhibitions, and to this promising new food product and its inventor, both gold and silver medals were awarded.

The only other article to which any prominence was given at the exposition as a dairy by-product was a form of dried casein called Protein, exhibited by an English company. There was quite a contest as to whether this should be recognized as a useful preparation or not, but it was finally given a silver medal.

### Illustrative Exhibit of Extent and Condition of Dairy Industry in the United States.

This description of the exposition of dairying at Paris would not be complete without mentioning the presentation which was made of the condition and extent of the industry in the United States. This comprised fine photographs of dairy cattle, of the buildings, equipment, and operations of several successful dairy schools, exterior and interior views of representative creameries and their work, and maps and statistical data. There was also a complete historical illustration, by photographs, of the development of the Babcock milk tester, which has contributed so much to economize and promote the dairy interests of the United States during the last ten or twelve years. (In this connection it may be stated that, by special action of the superior jury, the Grand Prix d'Honneur of the Paris Exposition was awarded to Dr. S. M. Babcock, of Wisconsin, as a fitting acknowledgment of this invaluable invention, and also of his having made a gift of it to the public.) The statistical maps showed the number and distribution of dairy cows in the United States, according to the latest available data, and the number and location of creameries and cheese factories in Iowa and New York. These two States were selected as being the largest producers of butter and cheese, respectively. For similar illustrative data by counties, four maps were added. Jefferson, Sheboygan, and Greene counties in Wisconsin, and Freeborn County, Minn., were chosen for this purpose. Jefferson shows the creamery system developed to a remarkable degree, and Freeborn well illustrates the rapid growth of this industry in the newer dairying districts of the Northwest. Sheboygan and Greene are representative counties, respectively, for large production of the standard American factory cheese and of the American imitations of some of the softer foreign varieties.

This report has intentionally omitted reference to dairy machinery, and appliances in general, exhibited at Paris by the United States and other countries, because those articles belong to an entirely distinct class of the exposition.

# WILLIAM SAUNDERS.

By The Editor.

The frontispiece to the Yearbook for 1900 is a portrait of William Saunders. Mr. Saunders filled an important place in the Department of Agriculture for thirty-eight years, and his death was a distinct loss to the public service.

It is not, however, in his capacity as a servant of the Government, a trusted, tried, and capable official of the Department for all these long years, that the place of honor in this number of the Yearbook is awarded him. Mr. Saunders's claim to a prominent place among those who have devoted their lives to the development of the agricultural interests in this country rests upon a far broader basis than his services as an official of this Department, essentially valuable as such services were. Before he entered the service of the Department in 1862, he was already well known as a landscape gardener and horticulturist, and a frequent and capable contributor on horticultural subjects to the leading periodicals of the day; he was identified, even at that early stage in his career, with numerous undertakings in which his skill and artistic ability as a landscape gardener have brought about results so beautiful and so useful that, were his name as prominently identified with them to-day as it deserves to be, he surely would need no other monument.

After entering the service of the Department he ever manifested the same deep interest in all undertakings connected with horticulture and gardening, and all the time he could spare from his official duties was given up to work of public utility. He constantly served, and without compensation, upon commissions of one kind or another, and always responded liberally with both his talents and his time to the numerous calls made upon him for counsel and advice.

His great interest in agriculture and in those who follow farming as a calling was manifested many years ago, when he became one of the founders of the National Grange.

Very few men have had better preparation for their life work than William Saunders. He came of a family of noted gardeners, and throughout his early life he enjoyed exceptional opportunities to study botany, horticulture, and landscape gardening in his native country. To an excellent general education, he added, besides a course in horticulture at Edinburgh College, several years' training in practical gardening. In February, 1848, he sailed for the United States and landed in New York on the 31st of the month following.

Mr. Saunders's first service in America was as gardener to Mr. Bostwick, at New Haven, Conn. While there he began his horticultural writings. The first article contributed by him in the New World was on the cultivation of *Leschenaultia formosa*. This article appeared in Hovey's Magazine, 1848. He contributed liberally to Hovey's Magazine of Horticulture, also to The Horticulturist, of which he was assistant editor for many years, the Philadelphia Florist, the Farmer and Gardener, and many others. It is a conservative estimate to say that the number of papers prepared by him on horticulture, landscape gardening, and agricultural subjects would reach over 3,000.

In 1854 Mr. Saunders formed a partnership with Thomas Meehan, at Germantown, Pa., in the business of landscape gardening and horticulture. At this time he introduced fixed roofs for greenhouses in this country, which, says Mr. Meehan, has resulted in a saving to gardeners of hundreds of thousands of dollars. In 1860 the business had attained such dimensions that he employed several hundred hands, including several engineers.

Among the various undertakings with which he was connected professionally was Clifton Park, Baltimore, an estate of some 400 acres, regarded at that time as the finest private property in America. He also designed the grounds of Thomas Winans in that city. He furnished plans for Fairmount and Hunting parks in Philadelphia, and laid out the beautiful cemeteries at Amboy and Rahway, N. J. In 1859 he was engaged in laying out the Rosehill Cemetery in Chicago, and another at Evanston, Ill. It was in this year also that he spent a day with Mr. Olmstead, the designer of Central Park, New York City, in looking over the ground devoted to that purpose. The tree planting in the grounds at Christ Church Hospital, Rahway, N. J., was done under his direction, and he furnished the design for the normal school grounds at Trenton, the same State. He supplied the designs for the Oak Ridge Cemetery near Springfield, Ill., and was called upon later (September, 1865) to select the site and design the grounds for the Lincoln Monument. This work was intrusted to him upon the suggestion of General Grant.

It was probably in connection with the laying out of the Gettysburg Cemetery that Mr. Saunders did his most important work for the Government as a landscape artist. Early in the fall of 1863 he was consulted by Mr. David Wells, of Gettysburg, Pa., acting as agent for Governor Curtin, and it was upon his advice that the area to be devoted to the cemetery was enlarged. From first to last the work was planned by Mr. Saunders, and measurements, drawings, and designs made by him were submitted to and approved by the cemetery commission. By President Lincoln's order the plans were submitted to him also, and on the evening of November 16, 1863, Mr. Saunders's attendance having been required at the President's office for the purpose, Mr.

Lincoln spent considerable time discussing them with him, and finally expressed his warm approval of them. Mr. Saunders's connection with this splendid memorial was the result of a convention of governors of States at Altoona, Pa., where it was decided that this important work should be intrusted to him. It is a singular fact that in spite of his being thus selected and of the immense amount of work which he performed in this connection, no provision was made at any time for any remuneration, even for his traveling expenses. From first to last the work was to him merely a labor of love. The only acknowledgment he ever received was a vote of thanks adopted at a meeting of the cemetery commissioners at Harrisburg in December, 1863, when his plans and designs were formally adopted. This vote was accompanied by the further resolution that Mr. Saunders be authorized to furnish forty photographs of the plans for the use of States having soldiers buried in the cemetery. This involved the redrawing of the plans so as to secure a suitable photograph, and no provision having been made for payment, the additional work was done and the photographs procured and paid for by Mr. Saunders himself.

While thus engaged in important work connected with his profession in many States of the Union, Mr. Saunders's definite location after 1862 in the city of Washington as an official of the Government naturally led to his close identification with the work of adorning that beautiful city.

Through Senator Morrill, who had been greatly impressed by Mr. Saunders's suggestions published in Sloan's Architectural Review and Builders' Journal (October, 1868), as to terracing the Capitol's western front, his ideas were practically adopted when this work was undertaken, with what results every visitor to Washington can testify.

Mr. Saunders also served almost constantly as one of the park commission, being for many years its secretary. His first appointment to this work was in conjunction with Messrs. W. Smith and John Saul in 1871, and the success which has attended the parking, tree planting, and the laying out of the park system, which now constitutes one of Washington's chief beauties, was largely due to Mr. Saunders's taste and skill. Mr. Saunders, indeed, very soon after his removal to Washington, established such a reputation for himself that he was frequently consulted by such men as General Grant, Senators Sherman, F. P. Blair, and others, all of whom seem to have been greatly impressed with his excellent judgment and taste and his wonderful foresight as to the future of the National Capital.

Among the most useful services rendered by Mr. Saunders to agriculture were his introductions of numerous valuable economic plants. That work, indeed, he began with his landing in this country, for he brought with him at that time several boxes of new plants, among them the *Cryptomeria japonica*, which had just been introduced into England by Robert Fortune. His interest in this kind of work never flagged, and throughout his entire service in the Department of Agriculture his efforts were especially directed to work of this character. It would be impossible to enumerate here every one of the economic plants now growing in the United States for whose introduction Mr. Saunders was responsible; only a few of the more important can be mentioned.

The first in importance, as well as one of the earliest chronologically, was the navel orange. His attention was first called to this by a lady who, writing in 1869 from Bahia, Brazil, spoke of a fine seedless orange growing there. Mr. Saunders promptly communicated with this lady, and eventually, through her efforts, secured twelve newly budded trees, from which have been propagated all the trees now so extensively grown in various parts of the country, and known as the Washington navel orange. One of these original trees is still to be seen in the orangery of the Agricultural Department at Washington, and is not infrequently visited by California orange growers, who salute it enthusiastically as the author of their fortunes.

With the assistance of a young Japanese educated in this country, whom Mr. Saunders had met in Washington, the Japan persimmon was successfully introduced, also in the sixties.

In 1866 Mr. Saunders procured from Brisbane, Queensland, and later from Baron von Mueller, of Melbourne, Victoria, seeds of *Eucalyptus globulus*, the blue gum tree of Australia. The demand for these trees increased rapidly, large supplies of seed were produced, and many thousands of trees distributed.

The camphor tree was introduced by Mr. Saunders as suitable for a shade tree in the South, and there are now thousands of these trees growing throughout the Southern States. The great increase in the price of camphor, due to the invention of smokeless gunpowder, promises to add to the money value of this beautiful tree, which will doubtless become the basis of an important industry.

One of our most useful hedge plants is the *Citrus trifoliata* of Japan, for whose introduction the country is also indebted to Mr. Saunders's efforts.

Mr. Saunders was early identified with Government exposition work. In March, 1874, he was appointed to represent the Department of Agriculture upon the board having charge of the Government exhibit at the Centennial Exposition. He served on the building committee and selected the site of the building, besides designing and executing all the plans for the Government grounds. While at the Centennial he secured much valuable material for the Department museum, and finally prepared an elaborate report upon the exposition, which was subsequently published. In connection with his work at the Centennial he was honored by the award of a magnificent medal, conferred "for services," by the United States Centennial Commission. Mr.

Saunders also represented the Department of Agriculture at the expositions of New Orleans, Cincinnati, and Louisville, and was actively connected with the Department exhibit prepared for the Paris Exposition of 1889. He himself contributed to this exhibit a plan of the Department grounds, which served to illustrate the success with which landscape gardening and scientific classification had been combined in laying out these grounds. Unpretentious as was this exhibit, this feature of it was so appreciated by the jury as to secure for Mr. Saunders, as its author, the award of a gold medal.

Widely as Mr. Saunders is known among horticulturists, landscape gardeners, nurserymen, etc., it is probably as one of the founders of the Grange that his name is most familiar to the great mass of farmers throughout the United States. As long ago as 1855, in a contribution to the American Farmer of Baltimore, Mr. Saunders outlined such an organization as the Grange afterwards became. It was not, however, until 1867 that the first grange was finally organized at Washington, D. C., by Mr. Saunders and six other gentlemen. The new organization adopted the name Patrons of Husbandry.

The preamble and constitution were written by Mr. Saunders, and these still stand as written. He was elected first master of the National Grange and served as such for six years, the hardest years of its existence. Subsequently, Mr. Saunders served efficiently as chairman of the executive committee. He has frequently been spoken of as the "Father of the granges." Although personally not inclined to the introduction of the secret feature in the Grange organization, Mr. Saunders was induced to concede it as necessary to secure proper discretion in the supervision of private matters. He was greatly interested in securing adequate representation of woman in the Grange, and having, as he believed, succeeded in this effort, he thus expressed himself in regard to it:

> We have taken a broad stride in the world's progress. We have given woman her true place. We not only make her eligible to our highest offices, but we have three places (Flora, Ceres, and Pomona) that only women can fill. You may call it the poetry of our order, but it is a part of the foundation as well as a principle, for no person can become a member until he has been consecrated and blessed by her hands.

It has been the effort of the writer of the present record to confine himself strictly to a recital of facts and to avoid anything like eulogy. Where a long life, however, has been so extensively devoted to good work, even the mere recital of facts must unavoidably bear the semblance of eulogium. In one respect, however, no effort will be made to avoid a frank expression of commendation of the public-spirited citizen whose work is here briefly reviewed. It is proper in presenting this record to the millions of readers of the Yearbook for their edification, and especially for imitation by the young, to whom his name can never be more than a memory, that special attention be directed to two features in Mr. Saunders's character. One of these is the earnestness with which, having once selected a career, he prepared himself for it, and unceasingly sought to develop and elevate it and to extend its usefulness. The other characteristic is the scrupulous integrity which distinguished every act of his official life. On many occasions when engaged on public business he served without pay, notwithstanding the vast amount of additional work thus entailed, and frequently, indeed, incurred considerable personal expense.

Mr. Saunders's career was in itself a living exemplification of the motto of his family, "He who tholes, conquers."

The following is a brief chronology of the principal events in the life of William Saunders: Born at St. Andrews, Scotland, 1822; married, 1848; emigrated to America, 1848; became an American citizen by naturalization in Philadelphia, Pa., 1857; appointed botanist and superintendent of propagating gardens, Department of Agriculture, 1862; died at Washington, D. C., September 11, 1900.

# APPENDIX.

## SUMMARY OF INFORMATION ON VARIOUS SUBJECTS OF INTEREST TO THE FARMER.

# CONTENTS.

# APPENDIX.

## ORGANIZATION OF THE DEPARTMENT OF AGRICULTURE, DECEMBER 31, 1900.

SECRETARY OF AGRICULTURE, James Wilson.

The Secretary of Agriculture is charged with the supervision of all public business relating to the agricultural industry. He appoints all the officers and employees of the Department, with the exception of the Assistant Secretary and the Chief of the Weather Bureau, who are appointed by the President, and directs the management of all the divisions, offices, and bureaus embraced in the Department. He exercises advisory supervision over the agricultural experiment stations deriving support from the National Treasury, and has control of the quarantine stations for imported cattle, and of interstate quarantine rendered necessary by contagious cattle diseases.

ASSISTANT SECRETARY OF AGRICULTURE, Joseph H. Brigham.

The Assistant Secretary performs such duties as may be required by law or prescribed by the Secretary. He also becomes Acting Secretary of Agriculture in the absence of the Secretary.

CHIEF CLERK, Andrew Geddes.

The Chief Clerk has the general supervision of the clerks and employees; of the order of business, records, and correspondence of the Secretary's office; of all expenditures from appropriations for contingent expenses, stationery, etc.; of the enforcement of the general regulations of the Department; and of the buildings occupied by the Department of Agriculture.

APPOINTMENT CLERK, Joseph B. Bennett.

The Appointment Clerk is charged by the Secretary with the preparation of all papers involved in making appointments, transfers, promotions, reductions, furloughs, or dismissals, and has charge of all correspondence of the Department with the United States Civil Service Commission. He deals with all questions as to positions in the Department which are under civil-service rules.

CHIEF OF SUPPLY DIVISION, Cyrus B. Lower.

The Supply Division has charge of purchases of supplies and materials paid for from the general funds of the Department.

### BUREAUS, DIVISIONS, AND OFFICES.

WEATHER BUREAU (corner Twenty-fourth and M streets NW.).—*Chief*, Willis L. Moore; *Chief Clerk*, Henry E. Williams; *Professors of Meteorology*, Cleveland Abbe, F. H. Bigelow, Alfred J. Henry, Charles F. Marvin, Edward B. Garriott.

The Weather Bureau has charge of the forecasting of weather; the issue of storm warnings; the display of weather and flood signals for the benefit of agriculture, commerce, and navigation; the gauging and reporting of rivers; the maintenance and operation of seacoast telegraph lines, and the collection and transmission of marine intelligence for the benefit of commerce and navigation; the reporting of temperature and rainfall conditions for the cotton, rice, sugar, and other interests; the display of frost and cold-wave signals; the distribution of meteorological information in the interests of agriculture and commerce; and the taking of such meteorological observations as may be necessary to establish and record the climatic conditions of the United States, or as are essential for the proper execution of the foregoing duties.

Bureau of Animal Industry.—*Chief*, D. E. Salmon; *Assistant Chief*, A. D. Melvin; *Chief Clerk*, S. R. Burch; *Chief of Inspection Division*, A. M. Farrington; *Chief of Miscellaneous Division*, Richard W. Hickman; *Chief of Pathological Division*, Victor A. Nörgaard; *Chief of Biochemic Division*, E. A. de Schweinitz; *Chief of Dairy Division*, Henry E. Alvord; *Zoologist*, Ch. Wardell Stiles; *In charge of Experiment Station*, E. C. Schroeder.

The Bureau of Animal Industry makes investigations as to the existence of contagious pleuro-pneumonia and other dangerous communicable diseases of live stock, superintends the measures for their extirpation, makes original investigations as to the nature and prevention of such diseases, and reports on the condition and means of improving the animal industries of the country. It also has charge of the inspection of import and export animals, of the inspection of vessels for the transportation of export cattle, and of the quarantine stations for imported neat cattle; supervises the interstate movement of cattle, and inspects live stock and their products slaughtered for food consumption.

Division of Statistics.—*Statistician and Chief*, John Hyde; *Assistant Statistician*, George K. Holmes.

The Division of Statistics collects information as to the condition, prospects, and harvests of the principal crops, and of the numbers, condition, and values of farm animals, through separate corps of county, township, and cotton correspondents, and individual farmers; and through State agents, each of whom is assisted by a corps of local reporters throughout the State. It obtains similar information from European countries monthly through consular, agricultural, and commercial authorities. It collects, tabulates, and publishes statistics of agricultural production, distribution, and consumption, the authorized data of governments, institutes, societies, boards of trade, and individual experts. It issues a monthly crop report and occasional bulletins for the information of the producers and consumers, and for their protection against combination and extortion in the handling of the products of agriculture.

Section of Foreign Markets.—*Chief*, Frank H. Hitchcock.

The Section of Foreign Markets makes investigations and disseminates information "concerning the feasibility of extending the demands of foreign markets for the agricultural products of the United States."

Office of Experiment Stations.—*Director*, A. C. True; *Assistant Director*, E. W. Allen.

The Office of Experiment Stations represents the Department in its relations to the experiment stations which are now in operation in all the States and Territories. It seeks to promote the interests of agricultural education and investigation throughout the United States. It collects and disseminates general information regarding the colleges and stations, and publishes accounts of agricultural investigations at home and abroad. It also indicates lines of inquiry of the stations, aids in the conduct of cooperative experiments, reports upon their expenditures and work, and in general furnishes them with such advice and assistance as will best promote the purposes for which they were established. It is also charged with investigations on the nutritive value and economy of human foods. The collection of valuable matter on irrigation from agricultural colleges and other sources, as provided in the appropriation bill, is conducted by this office.

Division of Chemistry.—*Chemist and Chief*, Harvey W. Wiley; *Assistant Chemist*, Ervin E. Ewell.

The Division of Chemistry makes investigations of the methods proposed for the analyses of soils, fertilizers, and agricultural products, and such analyses as pertain in general to the interests of agriculture. It can not undertake the analyses of samples of the above articles of a miscellaneous nature, but application for such analyses should be made to the directors of the agricultural experiment stations of the different States. The division does not make assays of ores nor analyses of minerals, except when related to general agricultural interests, nor analyses of water.

Division of Entomology.—*Entomologist and Chief*, L. O. Howard; *Assistant Entomologist*, C. L. Marlatt.

The Division of Entomology obtains and disseminates information regarding injurious insects, investigates insects sent to the division in order to suggest appropriate remedies, conducts investigations in economic entomology in different parts of the country, and mounts and arranges specimens for illustrative and museum purposes.

DIVISION OF BIOLOGICAL SURVEY.—*Biologist and Chief,* C. Hart Merriam; *Assistant Chief,* T. S. Palmer.

The Division of Biological Survey studies the geographic distribution of animals and plants, and maps the natural life zones of the country; it also investigates the economic relations of birds and mammals, and recommends measures for the preservation of beneficial and the destruction of injurious species.

DIVISION OF FORESTRY.—*Forester and Chief,* Gifford Pinchot; *Superintendent of Working Plans,* Overton W. Price.

The Division of Forestry investigates methods and trees for planting in the treeless West, gives practical assistance to tree planters, and also to farmers, lumbermen, and others, in handling forest lands. It studies commercial trees to determine their special values in forestry, and also studies forest fires and other forest problems.

DIVISION OF BOTANY.—*Botanist and Chief,* Frederick V. Coville; *Assistant Chief,* Lyster H. Dewey; *Special Agent in Charge of Section of Seed and Plant Introduction,* Jared G. Smith.

The Division of Botany investigates botanical agricultural problems, including the purity and value of agricultural seeds; methods of controlling the spread of weeds or preventing their introduction into this country; the dangers, effects, and antidotes for poisonous plants, the native plant resources of the country, and other subjects of economic botany. It introduces, tests, and distributes valuable seeds and plants from foreign countries.

DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY.—*Pathologist and Chief,* Albert F. Woods; *Assistant Pathologist,* Merton B. Waite.

The Division of Vegetable Physiology and Pathology has for its object a study of the normal and abnormal life processes of plants. It seeks by investigations in the field and experiments in the laboratory to determine the causes of disease and the best means of preventing the same. It studies plant physiology in its bearing on pathology.

DIVISION OF AGROSTOLOGY.—*Agrostologist and Chief,* F. Lamson-Scribner; *Assistant Chief,* Albert S. Hitchcock.

The Division of Agrostology is charged with the investigation of the natural history, geographical distribution, and uses of grasses and forage plants, their adaptation to special soils and climates, the introduction into cultivation of promising native and foreign kinds, and the preparation of publications and correspondence relative to these plants.

DIVISION OF POMOLOGY.—*Pomologist and Chief,* Gustavus B. Brackett; *Assistant Pomologist,* W. A. Taylor.

The Division of Pomology collects and distributes information in regard to the fruit interests of the United States; investigates the habits and peculiar qualities of fruits, their adaptability to various soils and climates, and conditions of culture; and introduces new and untried fruits from foreign countries.

DIVISION OF SOILS.—*Chief,* Milton Whitney; *Assistant Chief,* Lyman J. Briggs.

The Division of Soils is intrusted with the investigation, survey, and mapping of soils; the investigation of the cause and prevention of the rise of alkali in the soil, and the drainage of soils; and the investigation of the methods of curing and fermentation of tobacco in the different tobacco districts.

OFFICE OF PUBLIC ROAD INQUIRIES.—*Director,* Martin Dodge; *Assistant Director,* Maurice O. Eldridge.

The Office of Public Road Inquiries collects information concerning the systems of road management throughout the United States, conducts investigations and experiments regarding the best method of road making, and prepares publications on this subject.

EXPERIMENTAL GARDENS AND GROUNDS.—*Director of the Office of Plant Industry and Superintendent of Gardens and Grounds,* Beverly T. Galloway.

The Division of Gardens and Grounds is charged with the care and ornamentation of the park surrounding the Department buildings, and with the duties connected with the conservatories and gardens for testing and propagating economic plants.

DIVISION OF PUBLICATIONS.—*Editor and Chief,* Geo. Wm. Hill; *Assistant Chief,* Joseph A. Arnold; *Assistant in Charge of Document Section,* R. B. Handy.

The Division of Publications exercises general supervision of the Department printing and illustrations, edits all publications of the Department (with the exception of those of the Weather Bureau), has charge of the printing and Farmers' Bulletin funds, and distributes all Department publications with the exception of those turned over by law to the Superintendent of Documents for sale at the price affixed by him; it issues, in the form of press notices, official information of interest to agriculturists, and distributes, to agricultural publications and writers notices and synopses of Department publications.

DIVISION OF ACCOUNTS AND DISBURSEMENTS.—*Chief and Disbursing Clerk*, Frank L. Evans; *Assistant Chief* (in charge of Weather Bureau disbursements), A. Zappone; *Cashier*, Everett D. Yerby.

The Division of Accounts and Disbursements is charged with the adjustment of all claims against the Department; decides questions involving the expenditure of public funds; prepares estimates of appropriations needed; contracts for annual supplies, leases, and agreements; issues requisitions for the purchase of supplies, requests for passenger and freight transportations; and attends to all business relating to the financial interests of the Department, including payments of every description.

DIVISION OF SEEDS.—*Chief*, Robert J. Whittleton.

The Division of Seeds is charged with the purchase and distribution of valuable seeds. They are distributed in allotments to Senators, Representatives, Delegates in Congress, agricultural experiment stations, and by the Secretary of Agriculture, as provided by law.

LIBRARY.—*Librarian*, W. P. Cutter.[1]

The Librarian has charge of the Library and supervises the arrangement and cataloguing of books, the preparation of bibliographies and similar publications, and the purchases of new books.

## APPROPRIATIONS FOR THE DEPARTMENT OF AGRICULTURE FOR THE FISCAL YEARS ENDING JUNE 30, 1899, 1900, AND 1901.

| Object of appropriation. | 1899. | 1900. | 1901. |
|---|---|---|---|
| Salaries, Department of Agriculture | $319,300 | $336,340 | $326,680 |
| Furniture, cases, and repairs, Department of Agriculture | 9,000 | 10,000 | ........ |
| Library, Department of Agriculture | 6,000 | 5,000 | 5,000 |
| Museum, Department of Agriculture | 1,500 | 1,500 | ........ |
| Postage, Department of Agriculture | 2,000 | 2,000 | ........ |
| Contingent expenses, Department of Agriculture | 25,000 | 25,000 | 37,000 |
| Animal quarantine stations | 12,000 | 12,000 | 50,000 |
| Collecting agricultural statistics | 105,000 | 110,000 | 110,000 |
| Botanical investigations and experiments | 20,000 | 20,000 | 30,000 |
| Entomological investigations | 20,000 | 20,000 | 22,500 |
| Vegetable pathological investigations | 20,000 | 26,000 | 28,000 |
| Biological investigations | 17,500 | 17,500 | 17,500 |
| Pomological investigations | 9,500 | 9,500 | 9,500 |
| Laboratory, Department of Agriculture | 12,400 | 17,700 | 28,500 |
| Forestry investigations | 20,000 | 40,000 | 80,000 |
| Experimental gardens and grounds, Department of Agriculture | 20,000 | 28,000 | 20,000 |
| Soil investigations | 10,000 | 20,000 | 25,000 |
| Grass and forage plant investigations | 10,000 | 12,000 | 17,000 |
| Agricultural experiment stations, [$760,000, 1899; $765,000, 1900; $780,000, 1901] | 40,000 | 45,000 | 60,000 |
| Nutrition investigations | 15,000 | 15,000 | 17,500 |
| Public road inquiries | 8,000 | 8,000 | 14,000 |
| Publications, Department of Agriculture | 65,000 | 80,000 | 105,000 |
| Sugar investigations | 7,000 | 7,000 | 7,000 |
| Purchase and distribution of valuable seeds | 130,000 | 130,000 | 170,000 |
| Salaries and expenses, Bureau of Animal Industry | 900,000 | 950,000 | 1,000,000 |
| Irrigation investigations | 10,000 | 35,000 | 50,000 |
| Tea culture investigations | ........ | 1,000 | 5,000 |
| Arlington experimental farm | ........ | ........ | 10,000 |
| Total | 1,814,200 | 1,983,540 | 2,245,180 |
| *Weather Bureau.* | | | |
| Salaries, Weather Bureau | 153,340 | 153,320 | 153,320 |
| Fuel, lights, and repairs, Weather Bureau | 8,000 | 8,000 | 9,000 |
| Contingent expenses, Weather Bureau | 8,000 | 8,000 | 8,000 |
| General expenses, Weather Bureau | 765,162 | 768,162 | 828,000 |
| Meteorological observation stations | 75,000 | 60,000 | 60,000 |
| Erection of building at Sault Ste. Marie, Mich | 3,000 | ........ | ........ |
| Repairs to buildings and grounds, Bismarck, N. Dak | 3,000 | ........ | ........ |
| Building addition to Weather Bureau building, Washington | ........ | 25,000 | ........ |
| Total for Weather Bureau | 1,015,502 | 1,022,482 | 1,058,320 |
| Grand total | 2,829,702 | 3,006,022 | 3,303,500 |

[1] Since Jan. 1, 1901, Miss Josephine A. Clark has been Librarian.

## AGRICULTURAL COLLEGES AND OTHER INSTITUTIONS IN THE UNITED STATES HAVING COURSES IN AGRICULTURE.[1]

| State or Territory. | Name of institution. | Location. | President. |
|---|---|---|---|
| Alabama | Alabama Polytechnic Institute. | Auburn | W. L. Broun, LL. D. |
| | Agricultural and Mechanical College for Negroes. | Normal | W. H. Councill, Ph. D. |
| Arizona | University of Arizona | Tucson | M. M. Parker, M. A. |
| Arkansas | Arkansas Ind'l University | Fayetteville | J. L. Buchanan, LL. D. |
| | Branch Normal College | Pine Bluff | J. C. Corbin. |
| California | University of California | Berkeley | B. I. Wheeler, LL. D. |
| Colorado | The State Agricultural College of Colorado. | Fort Collins | B. O. Aylesworth, LL. D. |
| Connecticut | Storrs Agricultural College | Storrs | G. W. Flint, M. A. |
| Delaware | Delaware College | Newark | G. A. Harter, Ph. D. |
| | State College for Colored Students. | Dover | W. C. Jason, M. A., B. D. |
| Florida | Florida Agricultural College | Lake City | W. F. Yocum, M. A., D. D. |
| | Florida State Normal and Industrial College. | Tallahassee | T. De S. Tucker, M. A. |
| Georgia | Georgia State College of Agriculture and Mechanic Arts. | Athens | H. C. White, Ph. D. |
| Idaho | University of Idaho | Moscow | J. A. McLean, Ph. D. |
| Illinois | University of Illinois | Urbana | A. S. Draper, LL. D. |
| Indiana | Purdue University | Lafayette | W. E. Stone, Ph. D. |
| Iowa | Iowa State College of Agriculture and Mechanic Arts. | Ames | W. M. Beardshear, LL. D. |
| Kansas | Kansas State Agricultural College. | Manhattan | E. R. Nichols, M. A. |
| Kentucky | Agricultural and Mechanical College of Kentucky. | Lexington | J. K. Patterson, LL. D. |
| | State Normal School for Colored Students. | Frankfort | J. S. Hathaway, M. A., M. D. |
| Louisiana | Louisiana State University and Agricultural and Mechanical College. | Baton Rouge | T. D. Boyd, LL. D. |
| | Southern University and Agricultural and Mechanical College. | New Orleans | H. A. Hill. |
| Maine | The University of Maine | Orono | A. W. Harris, LL. D. |
| Maryland | Maryland Agricultural College. | College Park | R. W. Silvester. |
| Massachusetts | Massachusetts Agricultural College. | Amherst | H. H. Goodell, LL. D. |
| Michigan | Michigan State Agricultural College. | Agricultural College. | J. L. Snyder, Ph. D. |
| Minnesota | The University of Minnesota | St. Paul | C. Northrop, LL. D. |
| Mississippi | Mississippi Agricultural and Mechanical College. | Agricultural College. | J. C. Hardy, M. A. |
| | Alcorn Agricultural and Mechanical College. | Westside | W. H. Lanier, B. A. |
| Missouri | College of Agriculture and Mechanic Arts of the University of Missouri. | Columbia | R. H. Jesse, LL. D. |
| | Lincoln Institute | Jefferson City | J. H. Jackson, M. A. |
| Montana | The Montana College of Agriculture and Mechanic Arts. | Bozeman | J. Reid, A. B. |
| Nebraska | The University of Nebraska | Lincoln | E. B. Andrews, LL. D. |
| Nevada | Nevada State University | Reno | J. E. Stubbs, M. A., D. D. |
| New Hampshire | The New Hampshire College of Agriculture and the Mechanic Arts. | Durham | C. S. Murkland, Ph. D., D. D. |
| New Jersey | Rutgers Scientific School (The New Jersey State College for the Benefit of Agriculture and the Mechanic Arts). | New Brunswick | Austin Scott, LL. D. |
| New Mexico | The New Mexico College of Agriculture and Mechanic Arts. | Mesilla Park | F. W. Sanders, Ph. D. |
| New York | Cornell University | Ithaca | J. G. Schurman, LL. D. |
| North Carolina | The North Carolina College of Agriculture and Mechanic Arts. | West Raleigh | G. T. Winston, LL. D. |
| | The Agricultural and Mechanical College for the Colored Race. | Greensboro | J. B. Dudley, M. A. |
| North Dakota | North Dakota Agricultural College. | Agricultural College. | J. H. Worst. |
| Ohio | Ohio State University | Columbus | W. O. Thompson, D. D. |
| Oklahoma | Oklahoma Agricultural and Mechanical College. | Stillwater | A. C. Scott, M. A., LL. M. |
| | Agricultural and Normal University. | Langston | I. E. Page, M. A. |
| Oregon | Oregon State Agricultural College. | Corvallis | T. M. Gatch, Ph. D. |

[1] Including only institutions established under the land-grant act of July 2, 1862.

## AGRICULTURAL COLLEGES AND OTHER INSTITUTIONS IN THE UNITED STATES, ETC.—Continued.

| State or Territory. | Name of institution. | Location. | President. |
|---|---|---|---|
| Pennsylvania | The Pennsylvania State College. | State College | G. W. Atherton, LL. D. |
| Rhode Island | Rhode Island College of Agriculture and Mechanic Arts. | Kingston | J. H. Washburn, Ph. D. |
| South Carolina | Clemson Agricultural College | Clemson College | H. S. Hartzog, LL. D. |
| | The Colored Normal Industrial, Agricultural, and Mechanical College of South Carolina. | Orangeburg | T. E. Miller, LL. D. |
| South Dakota | South Dakota Agricultural College. | Brookings | J. W. Heston, LL. D. |
| Tennessee | University of Tennessee | Knoxville | C. W. Dabney, LL. D. |
| Texas | State Agricultural and Mechanical College of Texas. | College Station | L. L. Foster. |
| Utah | The Agricultural College of Utah. | Logan | W. J. Kerr, D. Sc. |
| Vermont | University of Vermont and State Agricultural College. | Burlington | M.H.Buckham, D. D., LL. D. |
| Virginia | Virginia Polytechnic Institute (State Agricultural and Mechanical College). | Blacksburg | J. M. McBryde, LL. D. |
| | The Hampton Normal and Agricultural Institute. | Hampton | H. B. Frissell, D. D. |
| Washington | Washington Agricultural College and School of Science. | Pullman | E. A. Bryan, M. A. |
| West Virginia | West Virginia University | Morgantown | J. H. Raymond, Ph. D. |
| | The West Virginia Colored Institute. | Institute | J. McH. Jones. |
| Wisconsin | University of Wisconsin | Madison | C. K. Adams, LL. D. |
| Wyoming | University of Wyoming | Laramie | E. E. Smiley, D. D. |

## AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES, THEIR LOCATIONS, DIRECTORS, AND PRINCIPAL LINES OF WORK.

| Stations, locations, and directors. | Number on staff. | Number of teachers on staff. | Principal lines of work. |
|---|---|---|---|
| Alabama (College), Auburn: P. H. Mell | 13 | 8 | Botany; soils; analyses of fertilizers and food materials; field and pot experiments; horticulture; diseases of plants; feeding experiments; diseases of animals. |
| Alabama (Canebrake), Uniontown: H. Benton | 3 | 2 | Soil improvement; field experiments; horticulture; floriculture; diseases of plants; diseases of animals. |
| Arizona, Tucson: R. H. Forbes | 9 | 7 | Chemistry; field experiments; meteorology; diseases of plants; horticulture (including date-palm orchard). |
| Arkansas, Fayetteville: R. L. Bennett | 8 | 2 | Chemistry of foods; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals. |
| California, Berkeley: E. W. Hilgard | 30 | 9 | Physics; chemistry and geographical distribution of soils; fertilizers; field crops; horticulture; botany; meteorology; technology of wine and olive oil, including zymology; chemistry of foods and feeding stuffs; entomology; drainage and irrigation; reclamation of alkali lands; plant introduction. |
| Colorado, Fort Collins: L. G. Carpenter | 16 | 8 | Chemistry; field experiments; horticulture; entomology; irrigation. |
| Connecticut (State), New Haven: E. H. Jenkins | 14 | | Analysis and inspection of fertilizers, foods, and feeding stuffs; chemistry; diseases of plants; horticulture; forestry; field experiments; entomology. |

## AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES, THEIR LOCATIONS, ETC.—Continued.

| Stations, locations, and directors. | Number on staff. | Number of teachers on staff. | Principal lines of work. |
|---|---|---|---|
| Connecticut (Storrs), Storrs: W. O. Atwater | 7 | 1 | Food and nutrition of man and animals; bacteriology of dairy products; field experiments; dairying. |
| Delaware, Newark: A. T. Neale | 8 | 7 | Chemistry; bacteriology; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology; dairying. |
| Florida, Lake City: W. F. Yocum | 11 | 5 | Chemistry; field experiments; horticulture; entomology. |
| Georgia, Experiment: R. J. Redding | 8 | 1 | Field experiments; horticulture; entomology; mycology; pig feeding; dairying. |
| Idaho, Moscow: J. A. McLean | 11 | 8 | Physics; botany; field experiments; horticulture; entomology; feeding experiments. |
| Illinois, Urbana: E. Davenport | 12 | 7 | Chemistry; bacteriology; field experiments; horticulture; forestry; diseases of plants; feeding experiments; entomology; dairying. |
| Indiana, Lafayette: C. S. Plumb | 11 | 7 | Chemistry; pot and field experiments; horticulture; feeding experiments; diseases of plants and animals. |
| Iowa, Ames: C. F. Curtiss | 20 | 14 | Chemistry; bacteriology; field experiments; horticulture; diseases of plants; feeding experiments; entomology; dairying. |
| Kansas, Manhattan: J. T. Willard | 15 | 12 | Soils; horticulture; seed breeding; field experiments; feeding and digestion experiments; diseases of animals; entomology. |
| Kentucky, Lexington: M. A. Scovell | 11 | 1 | Chemistry; soils; fertilizer analysis; field experiments; horticulture; diseases of plants; entomology; dairying. |
| Louisiana (Sugar), New Orleans: William C. Stubbs | ........ | ........ | Chemistry; bacteriology; soils and soil physics; field experiments; horticulture; sugar making; drainage; irrigation. |
| Louisiana (State), Baton Rouge: William C. Stubbs | 21 | 6 | Chemistry; geology; botany; bacteriology; soils; inspection of fertilizers and paris green; field experiments; horticulture; diseases of animals; entomology. |
| Louisiana (North), Calhoun: William C. Stubbs | ........ | ........ | Chemistry; soils; fertilizers; field experiments; horticulture; feeding experiments; stock raising; dairying. |
| Maine, Orono: C. D. Woods | 14 | 6 | Chemistry; botany; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; inspection of creamery glassware; horticulture; diseases of plants; seed tests; food and nutrition of man and animals; poultry raising; diseases of animals; entomology; dairying. |
| Maryland, College Park: H. J. Patterson | 16 | 8 | Chemistry; soils; field experiments; horticulture; diseases of plants; feeding experiments; entomology. |
| Massachusetts Amherst: H. H. Goodell | 20 | 8 | Chemistry; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; field experiments; horticulture; electro-germination; diseases of plants; digestion and feeding experiments; diseases of animals; entomology. |
| Michigan, Agricultural College: C. D. Smith | 16 | 7 | Bacteriology; soils; field experiments; horticulture; forestry; diseases of plants; feeding experiments; diseases of animals; entomology; apiculture; stable hygiene. |

## AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES, THEIR LOCATIONS, ETC.—Continued.

| Stations, locations, and directors. | Number on staff. | Number of teachers on staff. | Principal lines of work. |
|---|---|---|---|
| Minnesota, St. Anthony Park, St. Paul: W. M. Liggett | 15 | 7 | Chemistry; soils; field experiments; horticulture; forestry; diseases of plants; food and nutrition of man; plant and animal breeding; feeding experiments; diseases of animals; entomology; dairying. |
| Mississippi, Agricultural College: W. L. Hutchinson | 11 | 3 | Chemistry; soils; field experiments; horticulture; feeding experiments; dairying. |
| Missouri, Columbia: H. J. Waters | 14 | 6 | Chemistry; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology; drainage. |
| Montana, Bozeman: S. Fortier | 7 | 6 | Chemistry; meteorology; field experiments; horticulture; feeding experiments; poultry experiments; entomology; irrigation. |
| Nebraska, Lincoln: E. B. Andrews | 17 | 10 | Chemistry; botany; meteorology; soils; field experiments; horticulture; forestry; feeding and breeding experiments; diseases of animals; entomology; irrigation. |
| Nevada, Reno: J. E. Stubbs | 9 | 5 | Chemistry; botany; soils; field experiments; horticulture; forestry; feeding experiments; animal diseases; entomology; irrigation. |
| New Hampshire, Durham: C. S. Murkland | 15 | 12 | Chemistry; bacteriology; soil physics; field experiments; horticulture; diseases of plants; feeding experiments; entomology. |
| New Jersey (State), New Brunswick: E. B. Voorhees | 8 | 1 | Chemistry; biology; botany; analysis of fertilizers and foods; pot and field experiments; horticulture; diseases of plants; food and nutrition of man; diseases of animals; entomology; dairy husbandry; bacteria of milk; irrigation. |
| New Jersey (College), New Brunswick: E. B. Voorhees | 8 | 4 | |
| New Mexico, Mesilla Park: F. W. Sanders | 15 | 10 | Chemistry; soil physics; field experiments; horticulture; entomology; irrigation. |
| New York (State), Geneva: W. H. Jordan | 25 | ........ | Chemistry; bacteriology; meteorology; fertilizers; analysis and control of fertilizers; inspection of creamery glassware; field experiments; horticulture; diseases of plants; feeding experiments; poultry experiments; entomology; dairying. |
| New York (Cornell), Ithaca: I. P. Roberts | 19 | 7 | Chemistry of soils; feeding stuffs and dairy products; soils; fertilizers; field experiments; horticulture; diseases of plants; feeding sheep and swine; diseases of animals; poultry experiments; entomology; dairying. |
| North Carolina, Raleigh: G. T. Winston | 13 | 9 | Chemistry; field experiments; horticulture; analysis of feeding stuffs; digestion experiments; poultry experiments. |
| North Dakota, Agricultural College: J. H. Worst | 12 | 10 | Field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; dairying. |
| Ohio, Wooster: C. E. Thorne | 16 | ........ | Soils; field experiments; horticulture; diseases of plants; breeding and feeding experiments; diseases of animals; entomology. |
| Oklahoma, Stillwater: John T. Fields | 10 | 5 | Field experiments; horticulture; forestry; diseases of plants; digestion and feeding experiments; animal husbandry; diseases of animals; entomology. |
| Oregon, Corvallis: T. M. Gatch | 12 | 10 | Chemistry; soils; field crops; horticulture; diseases of plants; digestion and feeding experiments; entomology; dairying. |
| Pennsylvania, State College: H. P. Armsby | 20 | 8 | Chemistry: meteorology; fertilizer analysis; field experiments; feeding experiments; dairying. |

## AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES, THEIR LOCATIONS, ETC.—Continued.

| Stations, locations, and directors. | Number on staff. | Number of teachers on staff. | Principal lines of work. |
|---|---|---|---|
| Rhode Island, Kingston: A. A. Brigham | 15 | 4 | Chemistry; meteorology; soils; analysis and inspection of fertilizers and feeding stuffs; field and pot experiments; horticulture; poultry experiments. |
| South Carolina, Clemson College: H. S. Hartzog | 14 | 9 | Soils; analysis and control of fertilizers; field experiments; horticulture; plant breeding; diseases of plants; feeding experiments; veterinary science; entomology; dairying. |
| South Dakota, Brookings: J. H. Shepard | 12 | 5 | Bacteriology; chemistry of soils and soil physics; field experiments; forestry; diseases of plants; feeding experiments; entomology; irrigation. |
| Tennessee, Knoxville: Vice-director | 12 | 4 | Chemistry; soils; fertilizers; field experiments; horticulture; seeds; weeds; diseases of plants; feeding experiments; entomology; dairying. |
| Texas, College Station: J. H. Connell | 14 | 7 | Chemistry; soils; fertilizers; field experiments; horticulture; feeding dairy cows; sheep husbandry; diseases of animals; irrigation. |
| Utah, Logan: J. A. Widtsoe | 10 | 7 | Chemistry of soils and feeding stuffs; alkali soil investigations; meteorology; field experiments; horticulture; forestry; diseases of plants; cattle and sheep breeding; feeding experiments; dairying; poultry experiments; irrigation. |
| Vermont, Burlington: J. L. Hills | 13 | 5 | Chemistry; analysis and control of fertilizers and feeding stuffs; inspection of creamery glassware; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; dairying. |
| Virginia, Blacksburg: J. M. McBryde | 10 | 6 | Field crops; horticulture; cider and vinegar making; feeding experiments; veterinary science; entomology. |
| Washington, Pullman: E. A. Bryan | 12 | 7 | Chemistry; botany; soils; bacteriology; field experiments; horticulture; diseases of plants; feeding and breeding experiments; oyster culture; diseases of animals; entomology; dairying; irrigation. |
| West Virginia, Morgantown: J. H. Stewart | 12 | 4 | Chemistry; analysis and control of fertilizers; field experiments; horticulture; feeding experiments; poultry experiments; entomology. |
| Wisconsin, Madison: W. A. Henry | 21 | 16 | Chemistry; soils; field experiments; horticulture; feeding experiments; dairying; drainage and irrigation. |
| Wyoming, Laramie: E. E. Smiley | 8 | 6 | Geology; botany; meteorology; waters; soils; fertilizers; field experiments; food analysis; feeding experiments; entomology. |

## STATE OFFICIALS IN CHARGE OF AGRICULTURE.

*Secretary of Agriculture.*

Pennsylvania ................ John Hamilton ............... Harrisburg.

*Commissioners of Agriculture.*[1]

Alabama ..................... Robert R. Poole ............. Montgomery.
Arkansas .................... Frank Hill .................. Little Rock.
Florida ..................................................... Tallahassee.

[1] In several States the duties of the Commissioner of Agriculture are joined with the care of other interests also, as of mining and labor.

| | | |
|---|---|---|
| Georgia | O. B. Stevens | Atlanta. |
| Kentucky | I. B. Nall | Frankfort. |
| Louisiana | J. G. Lee | Baton Rouge. |
| Montana | J. A. Ferguson | Helena. |
| New York | Chas. A. Wieting | Albany. |
| North Carolina | S. L. Patterson | Raleigh. |
| North Dakota | R. J. Turner | Bismarck. |
| South Carolina | A. P. Butler | Columbia. |
| Tennessee | Thos. H. Paine | Nashville. |
| Texas | Jefferson Johnson | Austin. |
| Virginia | Geo. W. Koiner | Richmond. |
| Washington | W. P. C. Adams | Olympia. |

*State Engineer.*

| | | |
|---|---|---|
| Idaho | F. J. Mills | Boise. |

*Secretaries of State Boards of Agriculture.*

| | | |
|---|---|---|
| California | Peter J. Shields | Sacramento. |
| Colorado | A. M. Hawley | Fort Collins. |
| Connecticut | T. S. Gold | West Cornwall. |
| Delaware | Manlove Hayes | Dover. |
| Illinois | W. C. Garrard | Springfield. |
| Indiana | Chas. Downing | Indianapolis. |
| Kansas | F. D. Coburn | Topeka. |
| Maine | B. Walker McKeen | Augusta. |
| Massachusetts | J. W. Stockwell | Boston. |
| Michigan | Arthur C. Bird | Agricultural College. |
| Missouri | George B. Ellis | Columbia. |
| Nebraska | R. W. Furnas | Brownville. |
| Nevada | Louis Bevier | Carson City. |
| New Jersey | Franklin Dye | Trenton. |
| New Hampshire | N. J. Bachelder | Concord. |
| North Carolina | T. K. Bruner | Raleigh. |
| Ohio | W. W. Miller | Columbus. |
| Oregon | M. D. Wisdom | Portland. |
| Rhode Island | George A. Stockwell | Providence. |
| South Dakota | Walter B. Dean | Yankton. |
| Utah | H. P. Folsom | Salt Lake. |
| Vermont | C. J. Bell | East Hardwick. |
| West Virginia | J. B. Garvin | Charleston. |
| Wisconsin | John M. True | Madison. |

*Commissioner of Agriculture and Forestry.*

| | | |
|---|---|---|
| Hawaii | Wray Taylor | Honolulu. |

## SECRETARIES OF STATE AGRICULTURAL SOCIETIES.

| | | |
|---|---|---|
| Connecticut | B. W. Collins | Meriden. |
| Georgia | M. V. Calvin | Augusta. |
| Iowa | G. H. Van Houten | Des Moines. |
| Louisiana | W. H. Dalrymple | Baton Rouge. |
| Massachusetts | Leander F. Herrick | Worcester. |
| Maine | Geo. H. Clarke | North Anson. |
| Minnesota | E. W. Randall | Hamline. |
| Montana | Francis Pope | Helena. |
| Nevada | Wm. Hy. Doane | Reno. |
| New York | Edw. A. Callahan | Albany. |
| North Carolina | Joseph E. Pogue | Raleigh. |
| Pennsylvania | J. P. Nissley | Hummelstown. |
| South Carolina | T. W. Holloway | Pomaria. |
| Vermont | C. M. Winslow | Brandon. |

## OFFICIALS IN CHARGE OF FARMERS' INSTITUTES.

| State. | Name of official. | Post-office. |
|---|---|---|
| Alabama | Robert R. Poole, Commissioner of Agriculture | Montgomery. |
| | C. A. Cary, Alabama Polytechnic Institute | Auburn. |
| Arkansas | W. G. Vincenheller, Agricultural Experiment Station | Fayetteville. |
| California | E. J. Wickson, University of California | Berkeley. |
| | D. T. Fowler, for Central and Northern California | Do. |
| | A. J. Cook, for Southern California | Claremont. |
| Colorado | B. O. Aylesworth, President State Agricultural College | Fort Collins. |
| Connecticut | T. S. Gold, Secretary State Board of Agriculture | West Cornwall. |
| | George E. Manchester, Secretary Connecticut Dairymen's Association. | Winsted. |
| | H. C. C. Miles, Secretary Connecticut Pomological Society. | Milford. |
| Delaware | Wesley Webb, Superintendent Farmers' Institute for Kent County. | Dover. |
| | A. T. Neale, Superintendent for Newcastle County | Newark. |
| | S. H. Messick, Secretary for Sussex County | Bridgeville. |
| Florida | H. E. Stockbridge, Agricultural College | Lake City. |
| Georgia | H. C. White, President State College of Agriculture and Mechanic Arts. | Athens. |
| Illinois | A. B. Hostetter, Secretary and Superintendent of Farmers' Institutes. | Springfield. |
| | E. Davenport, Dean College of Agriculture, University of Illinois. | Urbana. |
| Indiana | W. C. Latta, Agricultural Experiment Station | Lafayette. |
| Iowa | Geo. Van Houten, Secretary State Board of Agriculture | Des Moines. |
| | W. M. Beardshear, President State College of Agriculture and Mechanic Arts. | Ames. |
| Kansas | J. T. Willard, Director Agricultural Experiment Station | Manhattan. |
| Kentucky | I. B. Nall, Commissioner of Agriculture | Frankfort. |
| | M. A. Scovell, Director Agricultural Experiment Station | Lexington. |
| Louisiana | L. Jastremski, Commissioner of Agriculture | Baton Rouge. |
| Maine | B. W. McKeen, Secretary State Board of Agriculture | Augusta. |
| Maryland | W. L. Amoss, Director Farmers' Institutes | Benson. |
| Massachusetts | J. W. Stockwell, Secretary State Board of Agriculture | Boston. |
| Michigan | C. D. Smith, Director Agricultural Experiment Station | Agricultural College. |
| Minnesota | O. C. Gregg, Superintendent Farmers' Institutes | Lynd. |
| Mississippi | W. L. Hutchinson, Director Agricultural Experiment Station. | Agricultural College |
| Missouri | Geo. B. Ellis, Secretary State Board of Agriculture | Columbia. |
| Montana | J. Reid, President College of Agriculture and Mechanic Arts. | Bozeman. |
| Nebraska | E. A. Burnett, University of Nebraska | Lincoln. |
| New Hampshire | N. J. Bachelder, Secretary State Board of Agriculture | Concord. |
| New Jersey | F. Dye, Secretary State Board of Agriculture | Trenton. |
| New York | F. E. Dawley, Director of Institutes | Fayetteville. |
| North Carolina | S. L. Patterson, Commissioner of Agriculture | Raleigh. |
| North Dakota | E. E. Kaufman, Assistant Dairy Commissioner | Fargo. |
| Ohio | W. W. Miller, Secretary State Board of Agriculture | Columbus. |
| Oregon | J. Withycombe, Vice-director Agricultural Experiment Station. | Corvallis. |
| Pennsylvania | A. L. Martin, Deputy Secretary of Agriculture | Harrisburg. |
| Rhode Island | G. A. Stockwell, Secretary State Board of Agriculture | Providence. |
| South Carolina | H. S. Hartzog, President Clemson Agricultural College | Clemson College. |
| South Dakota | S. A. Cochrane, Director Farmers' Institute | Brookings. |
| Tennessee | T. H. Paine, Commissioner of Agriculture | Nashville. |
| | Andrew M. Soule, Vice-director Agricultural Experiment Station. | Knoxville. |
| Texas | J. H. Connell, Director Agricultural Experiment Station | College Station. |
| Utah | W. J. Kerr, President Agricultural College | Logan. |
| Vermont | C. J. Bell, Secretary State Board of Agriculture | East Hardwick. |
| Virginia | G. W. Koiner, Commissioner of Agriculture | Richmond. |
| Washington | E. A. Bryan, Director Agricultural Experiment Station | Pullman. |
| West Virginia | D. M. Silliman, Institute Director | Charleston. |
| Wisconsin | G. McKerrow, Superintendent Farmers' Institutes | Madison. |

## ALLIED NATIONAL AGRICULTURAL SOCIETIES OF AMERICA.

President, J. C. Hanley, 400 Baltimore Block, St. Paul, Minn.

## NATIONAL LIVE STOCK ASSOCIATION.

President, John W. Springer, Denver; secretary, Charles F. Martin, Denver.

## AMERICAN RICE ASSOCIATION.

President, S. A. Knapp, Lake Charles, La.; secretary, Oswald Wilson, Houston, Tex.

## DAIRY OFFICIALS.

NATIONAL:

National Association of State Dairy and Food Departments.—Secretary, J. B. Noble, Hartford, Conn.

National Dairy Union.—Secretary Charles Y. Knight, 188 South Water street, Chicago, Ill.

National Creamery Buttermakers' Association.—Secretary, E. Sudendorf, Elgin, Ill.

New England Milk Producers' Union.—Secretary, L. S. Hayward, Pomfret Center, Conn.

Five States Milk Producers' Association.—Secretary, H. T. Coon, Little York, N. Y.

Columbia River Dairy Association.—Secretary, D. C. Dilworth, Spokane, Wash.

ALABAMA:

Alabama Dairymen's Association.—Secretary, F. H. Bates, Hamburg.

CALIFORNIA:

State Dairy Bureau.—Secretary and agent, William Vanderbilt, 114 California street, San Francisco.

California Dairy Association.—Secretary, Samuel E. Watson, 421 Market street, San Francisco.

Dairymen's Association of Southern California.—Secretary, Horace G. Hamilton, 1069 Temple street, Los Angeles.

COLORADO:

Dairy Commission.—Commissioner, T. L. Monson, Denver.

CONNECTICUT:

Dairy Commission.—Commissioner, John B. Noble, Hartford.

Connecticut Dairymen's Association.—Secretary, George E. Manchester, Station A, Winsted.

Connecticut Creamery Association.—Secretary, Frank Avery, Manchester.

GEORGIA:

Georgia Dairymen's Association.—Secretary, M. L. Duggan, Sparta.

ILLINOIS:

Food Commissioner.—Commissioner, Alfred H. Jones, room 1623 Manhattan Building, Chicago.

Illinois State Dairymen's Association.—Secretary, George Caven, 188 South Water street, Chicago.

Chicago Milk Shippers' Union.—Secretary, S. Hill, 94 Lasalle street, Chicago.

INDIANA:

State Dairy Association.—Secretary, H. E. Van Norman, Lafayette.

IOWA:

Dairy Commission.—Commissioner, B. P. Norton, Des Moines.

Iowa State Dairy Association.—Secretary, J. C. Daly, Charles City.

KANSAS:

Kansas State Dairy Association.—Secretary, T. A. Borman, White City.

MAINE:

Maine Dairymen's Association.—Secretary, L. W. Dyer, Cumberland Center.

MASSACHUSETTS:

Dairy Bureau.—General Agent State Dairy Bureau, George M. Whitaker, box 1332, Boston.

Massachusetts Creamery Association.—Secretary, A. W. Morse, Belchertown.

MICHIGAN:

Dairy and Food Commission.—Commissioner, W. B. Snow, Lansing.

Michigan Dairymen's Association.—Secretary, S. J. Wilson, Flint.

MINNESOTA:

Dairy and Food Commission.—Commissioner, W. W. P. McConnell, St. Paul.

Minnesota State Dairymen's Association.—Secretary, Robert Crickmore, Pratt.

Minnesota State Butter and Cheese Makers' Association.—Secretary, J. K. Bennett, Clinton Falls.

MISSOURI:

Missouri Dairymen's Association.—Secretary, Levi Chubbuck, 1214 Chemical Building, St. Louis.

NEBRASKA:

Food Commission.—Deputy Commissioner, F. B. Hibbard, Lincoln.

Nebraska Dairymen's Association.—Secretary, S. C. Bassett, Gibbon.

NEW HAMPSHIRE:

Granite State Dairymen's Association.—Secretary, J. L. Gerrish, Contoocook.

NEW JERSEY:

Dairy Commission.—Commissioner, George W. MacGuire, Trenton.

New Jersey State Dairy Union.—Secretary, G. L. Gillingham, Moorestown.

NEW YORK:
Department of Agriculture (including dairy).—Commissioner, Charles A. Wieting, Albany.
New York State Dairymen's Association.—Secretary W. W. Hall, Gouverneur.
NORTH CAROLINA:
North Carolina State Dairymen's Association.—Secretary, C. W. Gold, Wilson.
NORTH DAKOTA:
Commission of Agriculture.—Commissioner (and ex officio State dairy commissioner), H. U. Thomas, Bismarck.
North Dakota State Dairymen's Association.—Secretary, E. E. Kaufman, Fargo.
OHIO:
Dairy and Food Commission.—Commissioner Joseph E. Blackburn, Columbus.
Ohio State Dairymen's Association.—Secretary, James S. Devol, Marietta.
OREGON:
State Dairy and Food Commission.—Commissioner, J. W. Bailey, Portland.
Oregon Dairymen's Association.—Secretary, F. L. Kent, Corvallis.
PENNSYLVANIA:
Dairy and Food Commission (of State department of agriculture).—Commissioner, Jesse K. Cope, Harrisburg.
Pennsylvania Dairy Union.—Secretary, H. Hayward, State College.
Creamery Association of Eastern Pennsylvania.—Secretary, George R. Meloney, 1937 Market street, Philadelphia.
SOUTH DAKOTA:
South Dakota Dairy and Buttermaker's Association.—Secretary, C. P. Sherwood, Desmet.
TEXAS:
Dairymen's Association.—Secretary, S. T. Chapman, Redoak.
UTAH:
Food and Dairy Commission.—Commissioner, H. J. Faust, jr., Salt Lake City.
Utah Dairymen's Association.—Secretary, F. B. Linfield, Logan.
VERMONT:
Vermont Dairymen's Association.—Secretary, F. L. Davis, North Pomfret.
WASHINGTON:
Dairy and Food Commission.—Commissioner, E. A. McDonald, Seattle.
Washington State Dairymen's Association.—Secretary, D. S. Troy, Chimacum.
WISCONSIN:
Dairy and Food Commission.—Commissioner, H. C. Adams, Madison.
Wisconsin Dairymen's Association.—Secretary, George W. Burchard, Fort Atkinson.
Wisconsin Cheesemakers' Association.—Secretary, U. S. Baer, Madison.

## PROTECTION AGAINST CONTAGION FROM FOREIGN CATTLE.

An act of Congress of August 28, 1894, prohibits the importation of cattle and cattle hides, but by the act of March 2, 1895, making appropriations for the Department of Agriculture, it is provided that the prohibition may be suspended by the President whenever the Secretary of Agriculture shall certify to the President what countries or parts of countries are free from contagious or infectious diseases of domestic animals. The President, by proclamation of November 8, 1895, lifted the embargo with reference to Norway, Sweden, Holland, Great Britain, Ireland, the Channel Islands, and the countries of North, Central, and South America so as to admit cattle under sanitary regulations prescribed by the Secretary of Agriculture; also from all countries so as to admit hides under regulations prescribed by the Secretary of the Treasury.

## CATTLE BREEDERS' ASSOCIATIONS.[1]

American Aberdeen-Angus Breeders' Association.—Thomas McFarlane, Harvey, Ill., secretary. Number of registrations,[2] 34,936; date of first entry, November, 1883, Registration fees: For animals under 1 year old, to members, $1.50, nonmembers,

[1] Under the provisions of paragraph 473 of the act of July 24, 1897, any animal imported specially for breeding purposes shall be admitted free, provided that no such animal shall be admitted free unless pure bred, of a recognized breed, and duly registered in the book of record established for that breed.

The Secretary of the Treasury, upon the advice of the Secretary of Agriculture, issued, June 22, 1899, regulations for the importation of animals under this law, and designated the recognized breeds and the books of record established for these breeds.

[2] Number of registrations, January 1, 1900.

$2.50. Entries of ancestors to complete pedigrees, $1. Entries of native animals over 1 year old, $3 to members, $5 to nonmembers. Transfers free within 90 days, $1 after 90 days. Certified pedigrees, 50 cents; extended pedigrees, $1; duplicate certificates, 25 cents. Affiliated foreign society: Polled Cattle Society of Scotland, Dr. Alex Ramsay, secretary, Banff, Scotland. Eligible[1] to registry: American-bred animals whose sires and dams are recorded in American book, but application must be made within 2 years of birth, and imported animals recorded or tracing to the eighth or a prior volume of the affiliated Scotch book.

American Devon Cattle Club.—L. P. Sisson, Newark, Ohio, secretary.[2]

American Galloway Breeders' Association.—Frank B. Hearne, Independence, Mo., secretary. Number of registrations,[3] 16,395; first herdbook printed in 1883. Registration fees: To members for animals under 1 year, $1; over 1 year, $2; to nonmembers double; transfers, 25 cents if within 90 days, otherwise 50 cents. Affiliated foreign book: The Galloway Herd Book of Scotland, Rev. John Gillespie, secretary, Mouswald Manse, Ruthwell, R. S. O., Dumfriesshire, Scotland. Eligible to registry: Animals having sires and dams in the herdbook of this association or in the affiliated Scotch herdbook.

American Guernsey Cattle Club.—William H. Caldwell, Peterboro, N. H., secretary. Number of registrations:[3] Bulls, 6,878; cows, 13,080; date of first entry, 1878. Registration fees: Home-bred, under 6 months, $2, over 6 months, $3; imported, within 6 months after landing, $2, after 6 months, $3; members pay $1 less. All transfers $1. Affiliated foreign societies: English Guernsey Cattle Society, England; Royal Guernsey Agricultural Society, Guernsey; General Herdbook, Guernsey. Eligible to registry: Animals imported, or tracing through both sire and dam to animals imported from the island of Guernsey and registered in one of the affiliated herdbooks.

American Hereford Cattle Breeders' Association.—C. R. Thomas, Independence, Mo., secretary. Number of registrations: 120,000; date of first herdbook, 1879. Registration fees: To members, calves under 6 months, $1; over 6 months, $5; to nonmembers, double. Duplicate entries, 25 cents; to nonmembers, double. Transfers within 6 months of sale free to members, 25 cents to nonmembers; after 6 months, 50 cents to members; nonmembers, 75 cents. Duplicate certificates, 25 cents to members; nonmembers, double. Affiliated foreign society: Hereford Herd Book Society, 20 East street, Hereford, England. Eligible to registry: Animals whose sires and dams are recorded in the American book or in Volume XIII or prior volumes of the affiliated English book.

American Jersey Cattle Club.—J. J. Hemingway, No. 8 West Seventeenth street, New York, N. Y., secretary. Number of registrations: Bulls, 60,038; cows, 157,927; date of first entry, July, 1868. Registration fees: To members, for animals under 2 years, $1; nonmembers, $2. Animals over 2 years old, double. Entries of records of dead animals to complete pedigrees, $1. Transfers within 90 days, free; after 90 days, $1. Affiliated foreign society: Island of Jersey Royal Agricultural and Horticultural Society. Eligible to registry: American-bred animals whose sires and dams are recorded in the American book; to animals imported from the island of Jersey under certain regulations.

American Polled Durham Breeders' Association.—J. H. Miller, Peru, Ind., secretary.

American Shorthorn Breeders' Association.—John W. Groves, Springfield, Ill., secretary. Number of registrations: About 450,000; date of first herdbook, 1846. Registration fees: For all animals under 4 years, $1 each; over 4 years, $10 each; for recording pedigree of animal imported from Europe, $100; for extended copies with seal, 25 cents extra. Affiliated foreign book: English Shorthorn herdbook. Eligible to registry: Animals that trace back to recorded ancestry.

American Sussex Association.—Overton Lea, Nashville, Tenn., secretary. Number of registrations, 187. Registration fees: To members, $1; nonmembers, $3; fees double if not registered within 6 months of birth or importation. Affiliated foreign society: Sussex Herdbook Society. Eligible to registry: Animals registered in the English Sussex Herdbook, or the get of animals registered in the English or the American herdbook.

Ayrshire Breeders' Association.—C. M. Winslow, Brandon, Vt., secretary. Number of registrations: Bulls, 7,425; cows, 16,400; books revised at separation from Canadian book in 1876. Registration fees: To members, $1; nonmembers, $2; double rates for animals over 2 years old. Affiliated foreign book: Ayrshire

[1] Requirements for eligibility to registration can not be given fully in these lists of breeders associations. Only the more general conditions are stated; for particulars application must be made to the secretary of the association.

[2] In this and other cases in these lists of breeders' associations the lack of data as to registrations is due to failure to receive the necessary information from the association.

[3] Number of registrations January 1, 1900.

Herdbook of Scotland. Eligible to registry: Animals that trace in every branch to animals recorded in the books of this association or to the Scotch book.

Brown Swiss Cattle Breeders' Association.—N. S. Fish, Groton, Conn., secretary. Number of registrations: 3,540; date of first entry, September 8, 1880. Registration fees: For animals under 1 year old, $1 to members, $2 to nonmembers; for animals over 1 year old, double fees. Affiliated foreign society: None. Eligible to registry: Animals descended from registered animals in direct line.

Dutch Belted Cattle Association.—H. B. Richards, Easton, Pa., secretary. Number of registrations: Males, 422; females, 974; date of first entry, April 12, 1886, Registration fees: To members, animals under 6 months, $1; over 6 months, $2; to nonmembers, $1 more. Transfers within 30 days, $1; after 30 days, $2. Affiliated foreign society: None. Eligible to registry: All offspring of registered animals unless disqualified by physical defects.

Holstein-Friesian Association of America.—Frederick L. Houghton, Brattleboro, Vt., secretary. Number of registrations:[1] Bulls, 32,321; cows, 64,540; date of first entry, March 15, 1871. Registration fees: To members of association for males, $3; for females, $1; to nonmembers, for males $5, for females $2. Fees for animals over 1 year old double the ordinary. Affiliated foreign books: Friesch Rundvee-Stamboek; Nederlandsch Rundvee-Stamboek; North Holland Herd Book. Eligible to registry: Only such animals as are determined under the regulations of the association to be "pure bred."

Red Polled Cattle Club of America (incorporated).—J. McLain Smith, Dayton, Ohio, secretary. Number of registrations: Bulls, 7,773; cows, 16,082; date of first herdbook, new series, 1890. All cattle registered in the English book, as well as the American cattle, appear in these books. Registration fees: For animals under 1 year, $1 to members and $2 to nonmembers; over 1 year, 50 cents extra. Affiliated foreign society: The Red Polled Cattle Society of Great Britain and Ireland. Eligible to registry: Animals whose sires and dams are registered.

## HORSE BREEDERS' ASSOCIATIONS.

American Association of Importers and Breeders of Belgian Draft Horses.—J. D. Conner, jr., Wabash, Ind., secretary.

American Breeders' Association of Jacks and Jennets.—J. W. Jones, Columbia, Tenn., secretary. Number of registrations,[1] about 750; date of first entry, 1891. Registration fees: To members, $2 for living animals; transfers and certificates, $1 each; fees to nonmembers, double. Affiliated foreign society: All similar associations are in Spain. The American association will cooperate with any foreign society recommended by American consul, if such society is found to have satisfactory rules. Eligible to registry: All animals when black with light points, as follows: Native, 14½ hands high; imported, 14½ hands, if of unrecorded sire or dam; jacks of recorded ancestors if 14½ hands, jennets 14 hands.

American Cleveland Bay Breeders' Association.—R. P. Stericker, Attica, N. Y., secretary. Number of registrations,[1] 1,524; date of first entry, November 10, 1885. Registration fees: To members, stallions $2, mares $1; nonmembers, stallions $5, mares $3. Fees are doubled if animals are not recorded within two years from date of birth or importation. Affiliated foreign societies: Cleveland Bay Society of Great Britain and Ireland; Yorkshire Coach Horse Society of Great Britain and Ireland. Eligible to registry: Mares bred in America, four crosses by registered sires; stallions bred in America, five crosses by registered sires; stallion or mare whose sire and dam are both recorded in the American book or one of the affiliated foreign books, and imported animals recorded in one of the affiliated foreign books.

American Clydesdale Association.—Alex. Galbraith, Janesville, Wis., secretary. Number of registrations, 10,100, about one-half being stallions and one-half mares; date of first entry, 1879. Registration fees: To members owning stud books 1 to 8, inclusive, $3; nonmembers owning these books, $4; members not owning books, $4; nonmembers not owning books, $6. Transfers for members, $2; nonmembers, $4. Extended pedigree certificates, same terms as transfers. Affiliated foreign society: The Clydesdale Horse Society of Great Britain and Ireland, 93 Hope street, Glasgow, Scotland. Eligible to registry: Animals whose sire and dam are recorded in the American or affiliated English book; animals recorded in the English book; stallions having five top crosses and mares having four top crosses by sires recorded in American book; but unsound or unworthy animals will not be admitted.

American Hackney Horse Society.—A. H. Godfrey, room 50, Astor Court Building, West Thirty-fourth street, New York City, secretary. Number of registrations: Stallions, 602; mares, 1,140; mares inspected and recorded, 117. Registration fees: Members' stallions, $3; members' mares, $2; nonmembers double. Transfers for

[1] Number of registrations, January 1, 1900.

members, $2; nonmembers, $3. Inspection fees: Mare or filly certified to be sired by a "full-registered" hackney stallion, $2; other mares, $2 and actual expenses of inspectors. Affiliated foreign societies: English Hackney Horse Society, London, England, and Canadian Hackney Society, Toronto, Canada.

American Percheron Horse Breeders' Association.—S. D. Thompson, Chicago, Ill., secretary.

American Shetland Pony Club.—Mortimer Levering, Lafayette, Ind., secretary.

American Shire Horse Breeders' Association.—Charles Burgess, Wenona, Ill., secretary. Number of registrations, 5,924; date of first entry, November 1, 1886. Registration fees: To members, for each animal, $2; nonmembers, $5. Transfer, $1. Affiliated foreign society: The Shire Horse Society of Great Britain, J. Sloughgrove, secretary, Hanover Square, London, England. Eligible to registry: Stallions and mares whose sires and dams are recorded in the American book or the affiliated English book; stallions and mares recorded in the affiliated English book, and stallions having five top crosses and mares having four top crosses, in each case by sires recorded in the American book.

American Stud Book, Thoroughbred.—James E. Wheeler, 173 Fifth avenue, New York, N. Y., registrar. Number of registrations, 26,000. First stud book published about 1868, but systematic reports of foals began in 1893, when 1,506 were registered. Registration fees: $2 up to November 1 of the year in which the animal is foaled; after that date registration will be permitted upon a payment of a $50 fine, provided the failure to register is shown to have been unintentional or accidental. Affiliated foreign society: None. Eligible to registry: Only horses having either five uncontaminated thoroughbred crosses, or which authentically trace through or to animals recorded in the first six volumes of the American book, or in a recognized book of another country.

American Suffolk Punch Horse Association.—Alex. Galbraith, Janesville, Wis., secretary.

American Trotting Registry Association.—J. H. Steiner, room 1103, Ellsworth Building, 355 Dearborn street, Chicago, Ill., secretary. Number of registrations: Last volume of registry contained about 18,000 registrations; previous volumes not so many; fourteen in all; first published in 1871. Registration fees: To stockholders, $1; nonstockholders, $2; double for animals over 2 years old. Certificates of registration, 50 cents; transfers, 25 cents. Affiliated foreign society: Not stated. Eligible to registry: Animals whose pedigrees are established under the rules of the association.

French Coach Horse Society of America.—S. D. Thompson, Chicago, Ill., secretary.

German, Hanoverian, and Oldenburg Coach Horse Association of America.—J. Crouch, Lafayette, Ind., secretary. Number of registrations,[1] 600 stallions, 120 mares; date of first entry, December 30, 1889. Registration fees: To members, $2.50; nonmembers, $5 for each animal if application is made within four months of importation or birth; after that time, double fees. Transfers, $1 to members, $2 to nonmembers. Affiliated foreign society: None. Eligible to registry: Imported animals of properly authenticated foreign registry; native animals whose sires and dams are registered; and stallions having five crosses and mares having four crosses.

National French Draft Association.—C. E. Stubbs, Fairfield, Iowa, secretary. Number of registrations, 10,630; association organized February 9, 1876. Registration fees: To members, $2, nonmembers, $4; for transfer, $1 to members, $2 to nonmembers. Affiliated foreign society: French Draft Horse Stud Book. Eligible to registry: Imported animals properly vouched for by the affiliated French society; animals whose sires and dams are registered in the American book; stallions having five top crosses, and mares having four top crosses by sires recorded in the American book.

Select Clydesdale Horse Society of America.—E. Bennett, jr., Topeka, Kans., secretary.

The American Morgan Register.—Joseph Battell, Middlebury, Vt., treasurer. Number of registrations, about 5,000; date of first volume, 1894. Registration fees: Stallions 1 year old or over, $2; mares, geldings, and colts under 1 year, $1. Affiliated foreign society: None. Eligible to registry: Any meritorious animal tracing in direct male line to Justin Morgan and having at least one sixty-fourth of his blood: Provided, the dam and the sire's dam be of approved speed or roadster blood; any meritorious animal having one thirty-second or more of the blood of Justin Morgan: Provided, the dam and the sire's sire and dam be of approved speed or roadster blood; also any animal whose sire and dam are recorded in the Morgan Register.

The American Saddle Horse Breeders' Association.—I. B. Nall, Louisville, Ky., secretary. Number of registrations: Stallions and geldings, 1,572; mares, 1,895; date of first entry, July 31, 1891. Registration fees: To members, $1; nonmembers, $2; if registered during the year foaled, one-half. Affiliated foreign society: None. Eligi-

[1] Number of registrations to Jan. 1, 1900.

ble to registry: Horses having recognized gaits and tracing to registered animals under prescribed conditions.

The Oldenburg Coach Horse Association of America.—C. E. Stubbs, Fairfield, Iowa, secretary. Number of registrations,[1] 200 association incorporated March 5, 1892. Registration fees: To members, $2; nonmembers, $4. Transfers, $1 to members, $2 to nonmembers. If application is not made within one year from foaling or importation, the registration fee is $5. Affiliated foreign society: Gesellschaft Zuchter Oldenburger Kutschpferde, of Oldenburg, Germany. Eligible to registry: Any imported animal properly vouched for by the affiliated society; animals whose sires and dams are registered in the American book; stallions having five top crosses and mares having four top crosses by sires registered in the American book.

## SHEEP BREEDERS' ASSOCIATIONS.

American Cheviot Sheep Society (Amalgamated).—F. E. Dawley, Fayetteville, N. Y., secretary. Number of registrations, 2,797; in Cheviot flock books all associations amalgamated. 8,736; date of first entry, March 24, 1894. Registration fees: To members, 50 cents for lambs under 1 year; over 1 year, $1; nonmembers, double. Affiliated foreign society: The Cheviot Sheep Society of Great Britain, John Robson, Newton, Bellingham, Northumberland, England, secretary. Eligible to registry: Animals whose sires and dams are recorded in the books of the National Cheviot Sheep Society, the American Cheviot Sheep Breeders' Association or the affiliated British book.

American Cotswold Association.—George Harding, Waukesha, Wis., secretary. Number of registrations, over 23,000. Registration fees: Prior to April 1 following year of birth, 50 cents; over this age, $1; transfer, 25 cents. Affiliated foreign book: English Cotswold Flock Book. Eligible to registry: American-bred animals whose sires and dams are registered; imported animals having certificate from affiliated English book.

American Leicester Breeders' Association.—A. J. Temple, Cameron, Ill., secretary. Number of registrations: 4,840; date of first entry, July 24, 1888. Registration fees: To members, 50 cents; nonmembers, $1; transfers, 25 cents. Affiliated foreign society: None. Eligible to registry: American-bred animals whose sires and dams are recorded in the American book; imported animals registered in the flock books of Great Britain, or from reputable British flocks.

National Merino Sheep Register Association.—R. O. Logan, California, Mich., secretary.

American Oxford-Down Record Association.—W. A. Shafor, Hamilton, Ohio, secretary. Number of registrations: 22,831; date of incorporation of association, January, 1882. Registration fees: To members, 50 cents for each animal recorded before July 1 of next year succeeding birth; recorded after that date, $1. To nonmembers, $1 for any age. Transfers, 25 cents each. Affiliated foreign society: Oxford Down Sheep Breeders' Association, England. Eligible to registry: Animals imported from Great Britain if registered in the English flock book; native animals whose sires and dams are registered in the American Oxford Down Record.

American Southdown Association.—Frank S. Springer, Springfield, Ill., secretary. Number of registrations: 14,082; date of first entry, May 4, 1883. Registration fees: To members, for animals up to July 1 following birth, 50 cents; older, $1; to nonmembers, double. Transfers when filed with application for registry, free; within 6 months of sale, 25 cents; later, 50 cents. Affiliated foreign society: Southdown Sheep Society of England. Eligible to registry: American-bred animals that are immediate descendants of animals previously recorded in the association book; imported animals themselves recorded and numbered in English book, provided their sires and dams are also thus recorded and numbered.

American Shropshire Registry Association.—Mortimer Levering, Lafayette, Ind., secretary.

American Rambouillet Sheep Breeders' Association.—Dwight Lincoln, Milford Center, Ohio, secretary. Number of registrations, 15,000; date of first registration, 1889. Registration fees, 25 cents for ewes and 50 cents for rams. Transfers: To members, free; nonmembers, 10 cents; after 6 months, 25 cents to all. Eligible to registry, animals tracing with undoubted purity to government flock at Rambouillet, France.

American Suffolk Association.—Geo. A. Franklin, Des Moines, Iowa, secretary.

Black Top Spanish Merino Sheep Breeders' Association.—R. P. Berry, R. F. D. 4, Washington, Pa., secretary.

Delaine Merino Sheep Breeders' Association.—J. C. McNary, Houstonville, Pa., recording secretary; J. H. Hamilton, Canonsburg, Pa., corresponding secretary.

[1] Number of registrations to January 1, 1900.

Dickinson Merino Sheep Record Company.—H. G. McDowell, Canton, Ohio, secretary.

Dorset Horn Sheep Breeders' Association of America.—M. A. Cooper, Washington, Pa., secretary. Number of registrations,[1] 9,580; date of first entry, June 23, 1891. Registration fees, certificates under 1 year, 50 cents; over 1 year, $1; imported sheep, 50 cents; within 6 months, imported animals tracing in all their crosses to flocks of reputable breeders in England and their pure bred descendants in America and no others may be admitted upon proof of breeding; transfers, 25 cents.

Hampshire-Down Breeders' Association of America.—Comfort A. Tyler, Nottawa, Mich., secretary. Number of registrations, 10,719; date of first entry, December 30, 1889. Registration fees: Mature animals, $1; lambs, 50 cents up to January 1; fees to nonmembers, double. Affiliated foreign society: Hampshire-Down Sheep Breeders' Association (of England). Eligible to registry: Hampshire-Down sheep imported from or that can be traced in all their lines of descent to the flocks of reliable breeders in England.

Improved Black-top Merino Sheep Breeders' Association.—L. M. Crothers, Crothers, Pa., secretary. Number of registrations, about 3,000. Registration fees: To members, for each animal, 25 cents for registry; 15 cents transfer; nonmembers, 50 cents and 25 cents. Affiliated foreign society: Not stated.

Improved Delaine Merino Sheep Breeders' Association.—Geo. A. Henry, Bellefontaine, Ohio, secretary.

Michigan Merino Sheep Breeders' Association.—E. N. Ball, Hamburg, Mich., secretary. Number of registrations, about 50,000; date of first entry, 1880. Registration fees: For each flock of fifty or less, $5; over, 10 cents for each sheep. Affiliated foreign society: None. Eligible to registry (only for members of the association), animals tracing to flocks of breeders of pure American Merino sheep tracing to importations from Spain prior to 1812. Each breeder must keep a register of his flock.

National Improved Saxony Sheep Breeders' Association.—John G. Clarke, Washington, Pa., R. D. 9, secretary.

National Lincoln Sheep Breeders' Association.—H. A. Daniells, Millington, Mich., secretary. Number of registrations: 8,912; date of first entry, December 20, 1891. Registration fees: For lambs, 50 cents; sheep, $1. Affiliated foreign society: Lincoln Long Wool Sheep Breeders' Association of England. Eligible to registry: Only animals having registered sires and dams in American or English book.

New York State American Merino Sheep Breeders' Association.—J. H. Earll, Skaneateles, N. Y., secretary. Number of registrations: Not given; date of first entry, 1879. Registration fees: For ordinary register of lambs, 10 cents; for extended pedigree, 20 cents; for recording stock ram in list, 50 cents; for lambs not on file with secretary at time of annual meeting, 25 cents.

Ohio Spanish Merino Sheep Breeders' Association.—F. C. Stanley, Edison, Ohio. secretary.

Standard Delaine Spanish Merino Sheep Breeders' Association.—S. M. Cleaver, East Bethlehem, Pa., secretary. Number of registrations: —. Registration fees: For flock of 50, $10; for all over 50, 10 cents per head; to "others than members owning sheep records in this register," 25 cents per head. Affiliated foreign society: Not stated. Eligible to registry: Approved animals scaling 72 points or more. This minimum of 72 will be increased by one each year till 80 is reached.

Standard American Merino Register Association.—J. P. Ray, Hemlock, N. Y., secretary.

The Continental Dorset Club.—J. E. Wing, Mechanicsburg, Ohio, secretary. Number of registrations: 2,031; date of first entry, May 9, 1898. Registration fees: Native animals under 1 year, 50 cents; over 1 year, $1; imported, within 6 months of importation, 50 cents; after 6 months, $1; transfers, 25 cents. Affiliated foreign society: Dorset Horn Sheep Breeders' Association of England. Eligible to registry: Imported Dorset sheep bred by reputable breeders, and sheep tracing directly to such imported animals.

United States Merino Sheep Breeders' Registry Association.—J. A. B. Walker, Mountair, Pa., secretary.

Vermont, The, Atwood Merino Sheep Club Register.—George Hammond, Middlebury, Vt., secretary.

Vermont Merino Sheep Breeders' Association.—Lewis A. Skiff, Middlebury, Vt., secretary.

## SWINE BREEDERS' ASSOCIATIONS.

American Berkshire Association.—Charles F. Mills, 512 East Monroe street, Springfield, Ill., secretary. Number of registrations: 57,147; date of first entry, 1875. Registration fees: For native animals under 2 years, $1; over 2 years, $2; imported

[1] Number of registrations to January 1, 1900.

animals, within 6 months of importation, $1; after 6 months, $2. Transfers, 25 cents; certificates containing extended pedigree, 50 cents. Affiliated foreign society: British Berkshire Herd Book, Shipponabingdon, England. Eligible to registry: Animals that trace closely to ancestors registered in the 19 volumes of record of the association.

American Duroc-Jersey Swine Breeders' Association.—A. V. Bradrick, Shelbyville, Ind., secretary. Number of registrations: 10,950 females, 4,725 males; date of first entry, 1890. Registration fees: Animals under 2 years, $1; over 2 years, $2; transfers, 25 cents. Affiliated foreign society: Not stated.

American Essex Association.—F. M. Srout, McLean, Ill., secretary. Number of registrations: Boars, 1,890; sows, 3,010; date of first entry, September, 1887.

American Small Yorkshire Club.—G. W. Harris, 3409 Third avenue, New York, N. Y., secretary.

Cheshire Swine Breeders' Association.—B. B. Badger, Ouaquaga, N. Y., secretary, Number of registrations, 2,927.

Standard Chester White Record Association.—W. H. Morris, Indianapolis, Ind., secretary.—Number of registrations: Boars, 5,681; sows, 9,918; date of first registration, 1890. Registration fees: To members, 75 cents; nonmembers, $1. Eligible to registry: All animals the direct offspring of animals recorded or eligible to record in existing reputable records, but unrecorded ancestors must be recorded. Volume IX in press.

American Chester White Record Association.—Carl Freigau, Dayton, Ohio, secretary. Number of registrations: Boars, 3,579; sows, 5,502; date of first entry, October, 1884. Registration fees: To members, 50 cents for each animal; nonmembers, $1; transfers, 25 cents. Affilated foreign society: None. Eligible to registry: Chester White hogs on approval of the executive committee of the association.

American Poland-China Record Company.—W. M. McFadden, West Liberty, Iowa, secretary.

Central Poland-China Record Association.—W. H. Morris, Indianapolis, Ind., secretary. Number of registrations: Boars, 10,839; sows, 26,233; date of first entry, 1879. Registration fees: To members, 75 cents per head; nonmembers, $1. Eligible to registry: All animals the direct offspring of animals recorded in this record; also direct offspring of animals recorded in existing reputable records for Poland-China swine, provided they fill the pedigree of the Central Record, with recorded ancestors for three generations. Volumes of record issued annually; Volume XXII in press.

Ohio Poland-China Record Company.—Carl Freigau, Dayton, Ohio, secretary. Number of registrations: Boars, 25,226; sows, 60,203; date of first registration, March, 1877. Registration fees: Animals under 2 years, $1; over 2 years, $2. Affiliated foreign society: None. Eligible to registry: Animals whose pedigrees had already appeared in some reputable record previous to the fall of 1883, thus furnishing the evidence that the ancestors on both sides trace direct to pure Poland-China stock as originated in southwestern Ohio.

Standard Poland-China Record Association.—George F. Woodworth, Maryville, Mo., secretary. Number of registrations, 87,598; date of first herdbook, 1887. Registration fees: To stockholders, 50 cents; nonstockholders, $1; transfers, 25 cents. Affiliated foreign society: None. Eligible to registry: All animals the direct offspring of animals recorded or eligible to record in existing reputable records; unrecorded ancestors must be recorded.

Victoria Swine Breeders' Association.—H. Davis, Dyer, Ind., secretary.

Suffolk Swine Association.—W. F. Watson, Winchester, Ind., secretary.

National Duroc-Jersey Record Association.—R. J. Evans, El Paso, Ill., secretary. Number of registrations: Males, 5,000; females, 11,200. Date of first entry, October 15, 1891. Registration fees: To members, 50 cents; nonmembers, $1; for animals over 2 years old, one-half more. Affiliated foreign society: None. Eligible to registry: Animals whose sires and dams are recorded in either the National or the American Duroc-Jersey record and which are pure red, cherry being the choicest shade.

The American Tamworth Swine Record Association.—E. N. Ball, Hamburg, Mich., secretary. Number of registrations, 800; date of first entry, February 16, 1898. Registration fees: To members, 50 cents; to nonmembers, $1. Affiliated foreign book: The National Pig Breeders' Association Herdbook of England. Eligible to registry: Only animals whose sires and dams are recorded in the American book or tracing to the affiliated English book.

The American Yorkshire Club.—Mrs. E. W. Wilcox, Hugo, Minn., secretary.

## ASSOCIATIONS OF BREEDERS OF GOATS, HARES, DOGS, ETC.

American Kennel Club.—A. P. Vredenburgh, 55 Liberty street, New York, N. Y., secretary.

National Belgian Hare Club of America, Incorporated.—Roe E. Remington, Montclair, Col., secretary.

The American Angora Goat Breeders' Association.—W. T. McIntire, 277 Live Stock Exchange, Kansas City, Mo.

National Angora Goat Record Association.—Henry B. Thielsen, Salem, Oreg.

## POULTRY ASSOCIATIONS.

*National and interstate organizations.*

| Name of association. | Secretary. | Post-office. |
|---|---|---|
| American Dorking Club | F. H. Prentice | North Grafton, Mass. |
| American Buff Plymouth Rock Club | W. C. Denny | Rochester, N. Y. |
| American Black Minorca Club | John A. Gamewell | Hackensack, N. J. |
| American Cochin Club | Arthur R. Sharp | Taunton, Mass. |
| National Exhibition Game and Game Bantam Club. | J. C. Pratt | 170 Adams street, Chicago. |
| American Houdan Club | Thomas F. Rigg | Iowa Falls, Iowa. |
| American Leghorn Club | Geo. H. Burgott | Lawtons Station, N. Y. |
| American Plymouth Rock Club | H. P. Schwab | Rochester, N. Y. |
| Cornish Indian Game Club of America | W. S. Templeton | Dakota, Ill. |
| Eastern White Wyandotte Club | W. E. Mack | Woodstock, Vt. |
| Minorca Club of Northwest | Dr. H. B. Fay | Minneapolis, Minn. |
| National Bantam Association | E. Latham | Flatbush, Long Island, N. Y. |
| New England Light Brahma Club | G. W. Cromack | Stoneham, Mass. |
| National Poultry and Pigeon Association | Geo. E. Howard | Washington, D. C. |
| National Fanciers' Association | Fred L. Kinney | Morgan Park, Ill. |
| Boston Poultry Association | C. Minot Weld | 131 Devonshire street, Boston, Mass. |
| Wolverine P. P. and P. S. Association | Gus Williams | Bay City, Mich. |
| St. Louis Fanciers' Association | John A. Francisco | 1201 Lincoln Tr. Bld., St. Louis, Mo. |
| Mid-Continental Poultry Association | F. M. Slutz | Kansas City, Mo. |
| Interstate Poultry Association | R. Horrocks | Falls City, Nebr. |
| Buffalo Poultry Association | E. C. Pease | Buffalo, N. Y. |
| Madison Square Garden (New York) Poultry and Pig Association. | H. V. Crawford | Montclair, N. J. |
| Northern Ohio Poultry and Pet Stock Association. | F. R. Hunt | Cleveland, Ohio. |
| Buckeye Poultry Association | Geo. B. Wetzel | Dayton, Ohio. |
| Tri-State Poultry Association | J. A. McIntosh | East Liverpool, Ohio. |
| Pittsburg Fanciers' Club | A. P. Robinson | 110 Second avenue, Pittsburg, Pa. |
| Piedmont Poultry Association | B. W. Getsinger | Spartanburg, S. C. |
| Nashville Poultry Association | J. M. Hopkins | Nashville, Tenn. |
| Tacoma Poultry Association | C. C. Johns | 402 Berlin Building, Tacoma, Wash. |
| Western Bantam Breeders' Association | A. E. Brown | Morgan Park, Ill. |

*Secretaries of State poultry associations.*

| State. | Secretary. | Post-office. |
|---|---|---|
| Colorado | Frank E. Kimball | Denver. |
| District of Columbia | Geo. E. Howard | Washington. |
| Illinois | Edward Craig | Albion. |
| Kansas | George H. Gillies | Topeka. |
| Kentucky | Charles Hess | Louisville. |
| Michigan | John A. Grover | Concord. |
| Missouri | Mrs. E. A. Creal | Carrollton. |
| Nebraska | L. W. Garoutte | Lincoln. |
| Oklahoma | L. F. Laverty | Guthrie. |
| Rhode Island | H. S. Babcock | Providence. |
| Tennessee | M. D. Andes | Bristol. |
| Utah | Geo. Laysum | 129 W. First South street, Salt Lake City. |
| Vermont | J. S. Eaton | Woodstock. |

## STATE ASSOCIATIONS OF BREEDERS.

Colorado Cattle Growers' Association.—Secretary, H. H. Metcalf, Denver.
Connecticut Sheep Breeders' Association.—Secretary, John H. Wadhams, Goshen.
Illinois Live Stock Breeders' Association.—Secretary, Fred H. Rankin, Athens.
Illinois Horse Breeders' Association.—Secretary, George Williams, Athens.
Illinois Cattle Breeders' Association.—Secretary, Samuel E. Prather, Springfield.
Illinois Cattle Feeders' Association.—Secretary, Charles F. Mills, Springfield.
Illinois Sheep Breeders' Association.—Secretary, Frank S. Springer, Springfield.
Illinois Swine Breeders' Association.—Secretary, Charles F. Mills, Springfield.
Kansas Improved Stock Breeders' Association.—Secretary, H. A. Heath.
Kentucky Swine Breeders' Association.—Secretary, M. W. Neal, Louisville.
Nebraska Improved Live Stock Breeders' Association.—Secretary, H. F. McIntosh, Omaha.
Nebraska Swine Breeders' Association.—Secretary, E. B. Trough, Minden.
Texas Live Stock Association.—Secretary, W. R. Spann, Dallas.
West Virginia Sheep Breeders and Wool Growers' Association.—Secretary, James Beall, Independence, Pa.
The American Tunis Sheep Breeders' Association.—Secretary, M. A. Bridges, Fincastle, Ind.

## STATE VETERINARIANS AND SECRETARIES OF SANITARY BOARDS.

ALABAMA:
Dr. W. H. Sanders, Montgomery, State health officer.
ARIZONA:
H. Harrison, Phoenix, secretary live-stock sanitary commission.
Dr. J. C. Norton, Phoenix, veterinarian.
CALIFORNIA:
Dr. W. P. Matthews, Sacramento, secretary State board of health.
Dr. Charles H. Blemer, Sacramento, State veterinarian.
COLORADO:
B. H. Du Bois, Denver, president State veterinary sanitary board.
Dr. G. E. Tyler, State capitol, Denver, secretary State board of health.
Dr. Solomon Bock, Denver, State veterinary surgeon.
E. McCrillis, Capitol building, Denver, secretary State board of stock inspection commissioners.
CONNECTICUT:
Dr. C. A. Lindsley, New Haven, secretary State board of health.
Heman O. Averill, Capitol, Hartford, commissioner for domestic animals.
DELAWARE:
Dr. Alex Lowber, Wilmington, secretary State board of health.
FLORIDA:
Dr. Joseph Y. Porter, Key West, secretary State board of health.
IDAHO:
T. G. Lowe, Franklin, State sheep inspector.
ILLINOIS:
Dr. J. A. Egan, Springfield, secretary State board of health.
Dr. C. P. Lovejoy, Princeton, State veterinarian.
C. P. Johnson, Springfield, secretary board of live-stock commissioners.
INDIANA:
Dr. J. N. Hurty, Indianapolis, secretary State board of health.
Dr. F. A. Bolser, Newcastle, State veterinarian.
Mortimer Levering, Lafayette, secretary State live-stock sanitary commission.
IOWA:
Dr. J. I. Gibson, Denison, State veterinary surgeon.
Dr. J. F. Kennedy, Des Moines, secretary State board of health.
KANSAS:
Dr. W. B. Swan, Topeka, secretary State board of health.
M. C. Campbell, Wichita, secretary live-stock sanitary commission.
KENTUCKY:
Dr. J. N. McCormack, Bowling Green, secretary State board of health.
Dr. F. T. Eisenman, Louisville, State veterinarian.
LOUISIANA:
Dr. Will R. Harman, New Orleans, secretary State board of health.

MAINE:
Dr. A. G. Young, Augusta, secretary State board of health.
Dr. George H. Bailey, Deering, State veterinarian.
F. O. Beal, Bangor, John M. Deering, Saco, and F. S. Adams, Bowdoimham, cattle commissioners.

MARYLAND:
Dr. John S. Fulton, 10 South street, Baltimore, secretary State board of health.
Dr. H. A. Meisner, Merchants' Nat. Bank, Baltimore, chief veterinary inspector.

MASSACHUSETTS:
Dr. Samuel W. Abbott, Boston, secretary State board of health.
Dr. Austin Peters, Boston, president board of cattle commissioners.

MICHIGAN:
Dr. Henry B. Baker, Lansing, secretary State board of health.
Dr. George W. Dunphy, Quincy, State veterinarian.
J. H. Brown, Battle Creek, president State live-stock sanitary commission.

MINNESOTA:
Dr. M. H. Reynolds, St. Anthony Park, St. Paul, director veterinary department of State board of health.
Dr. H. M. Bracken, St. Paul (Pioneer Press Building), secretary State board of health.

MISSISSIPPI:
Dr. John F. Hunter, Jackson, secretary State board of health.
Dr. J. C. Robert, Agricultural College, professor of veterinary science.

MISSOURI:
Dr. Willis P. King, Kansas City (Fountain place), secretary State board of health.
Dr. D. F. Luckey, Columbia, State veterinarian.
Geo. B. Ellis, Columbia, secretary State board of agriculture.

MONTANA:
Dr. M. E. Knowles, Helena, State veterinarian.

NEBRASKA:
H. R. Corbet, Lincoln, secretary State board of health.
Dr. A. T. Peters, Lincoln, secretary State veterinary association.

NEVADA:
Dr. W. H. Patterson, Reno, secretary State board of health.

NEW HAMPSHIRE:
Dr. Irving A. Watson, Concord, secretary State board of health.
N. J. Bachelder, Concord, secretary board of cattle commissioners.

NEW JERSEY:
Dr. Henry Mitchell, Trenton, secretary State board of health.
Franklin Dye, Trenton, secretary tuberculosis commission.

NEW MEXICO:
Dr. J. M. Cunningham, East Las Vegas, secretary State board of health.
J. H. La Rue, East Las Vegas, secretary cattle sanitary board.
Harry F. Lee, Albuquerque, secretary sheep sanitary board.

NEW YORK:
Dr. Baxter T. Smelzer, Albany, secretary board of health.
F. W. Smith, 700 South West street, Syracuse, secretary tuberculosis committee.

NORTH CAROLINA:
Dr. Richard H. Lewis, Raleigh, secretary board of health.
S. L. Patterson, commissioner of agriculture.

NORTH DAKOTA:
Dr. J. W. Dunham, Fargo, chief State veterinarian.
Dr. John Montgomery, Ardoch, secretary board of health.

OHIO:
Dr. C. O. Probst, Columbus, secretary board of health.
Dr. H. J. Detmers, Columbus, veterinary surgeon, State University.
Dr. D. N. Kinsman, Columbus, secretary live-stock commission.

OKLAHOMA:
Dr. C. D. Arnold, Kingfisher, superintendent board of health.
W. E. Bolton, Woodward, secretary live-stock sanitary commission.

OREGON:
Dr. William McLean, Portland, State veterinarian.

PENNSYLVANIA:
Dr. Benjamin Lee, 1532 Pine street, Philadelphia, secretary State board of health.
Dr. Leonard Pearson, 3608 Pine street, Philadelphia, State veterinarian.

RHODE ISLAND:
Dr. Arthur L. Parker, Providence, veterinarian to State board of health.
Dr. Gardner T. Swarts, Providence, secretary State board of health.
John S. Pollard, veterinarian State board of agriculture.

SOUTH CAROLINA:
Dr. James Evans, Florence, secretary board of health.
Dr. G. E. Nesom, Clemson College, State veterinarian.
SOUTH DAKOTA:
J. L. Harris, Webster, secretary board of health.
Dr. J. W. Elliot, Aberdeen, State veterinarian.
TENNESSEE:
Dr. J. A. Albright, Somerville, secretary State board of health.
W. H. Dunn, live-stock commissioner, Nashville.
Dr. J. W. Sheibler, Memphis, State veterinarian.
TEXAS:
Dr. R. M. Swearingen, Austin, State health officer.
Robert J. Kleberg, Corpus Christi, secretary live-stock sanitary commission.
UTAH:
Dr. T. B. Beatty, Salt Lake City, secretary State board of health.
VERMONT:
C. S. Caverly, Rutland, secretary board of health.
C. J. Bell, East Hardwick, secretary cattle commission.
VIRGINIA:
Dr. Paulus A. Irving, Richmond, secretary board of health.
Dr. E. P. Niles, Blacksburg, State veterinarian.
WASHINGTON:
Dr. Elmer E. Heg, North Yakima, secretary board of health.
Dr. S. B. Nelson, Pullman, veterinarian agricultural experiment station.
WEST VIRGINIA:
Dr. A. R. Barbee, Point Pleasant, secretary State board of health.
J. B. Garven, Charleston, secretary board of agriculture.
WISCONSIN:
Dr. Evan D. Roberts, Janesville, State veterinarian.
Dr. U. O. B. Wingate, Milwaukee, secretary board of health.
WYOMING:
Dr. George T. Seabury, Cheyenne, State veterinarian.
George East, president, board of live-stock commissioners.

## STATES HAVING OFFICES FOR FOREST WORK.

KANSAS.—Forestry commissioner, R. M. Wright, Dodge City.
MAINE.—Forestry commissioner, Charles E. Oak, Augusta.
MICHIGAN.—Forestry commission, Charles W. Garfield, president, Grand Rapids.
MINNESOTA.—Fire warden, Gen. C. C. Andrews, St. Paul.
Forest commissioner, R. C. Dunn, St. Paul.
State forestry board, Orville M. Lord, Minnesota City.
NEW HAMPSHIRE.—Forest commission, George H. Moses, secretary, Concord.
NEW JERSEY.—Geological survey, Prof. John C. Smock, State Geologist, Trenton.
NEW YORK.—Forest, fish, and game commission, Lieut. Gov. Timothy L. Woodruff, chairman.
Superintendent of State forests.—William F. Fox, Albany.
NORTH CAROLINA.—Geological survey, Prof. J. A. Holmes, State Geologist, Chapel Hill.
NORTH DAKOTA.—State superintendent of irrigation and forestry, W. W. Barrett, Bismarck.
OREGON.—Game and forestry warden, L. P. W. Quimby, Portland.
PENNSYLVANIA.—Department of forestry, Dr. J. T. Rothrock, commissioner, Harrisburg.
WEST VIRGINIA.—Geologic and economic survey, Dr. I. C. White, superintendent, Morgantown.
WISCONSIN.—State forest warden, C. E. Morley, Madison.

## FORESTRY ASSOCIATIONS.

NATIONAL:
American Forestry Association.—President, Hon. James Wilson, Secretary of Agriculture; secretary (corresponding), F. H. Newell, United States Geological Survey, Washington, D. C.
CALIFORNIA:
California Water and Forest Association.—President, William Thomas, San Francisco; secretary, T. C. Friedlander, San Francisco.
Sierra Club.—President, John Muir, Martinez, Cal.; secretary (corresponding) Prof. W. R. Dudley, Stanford University, Cal.

CALIFORNIA—Continued.

Forest and Water Society of Southern California, having a branch in each southern county.—President, Abbot Kinney, Los Angeles; secretary, William H. Knight, Los Angeles.

Salt River Valley (California) Water Supply Protective Association.—President, Jerry Millay; secretary, H. M. Chapman.

COLORADO:

Colorado Forestry Association.—President, William N. Byers, Denver; secretary, D. W. Working, Denver.

CONNECTICUT:

Connecticut Forestry Association.—President, Maj. Edward V. Preston, Travelers' Insurance Company, Hartford; secretary (corresponding), Miss Mary Winslow, Weatogue.

INDIANA:

Indiana Forestry Association.—President, Albert Lieber, Indianapolis; secretary, John P. Brown, Connersville.

MASSACHUSETTS:

Massachusetts Forestry Association.—President, Henry P. Walcott, Cambridge; secretary, J. Woodward Manning, 1150 Tremont Building, Boston.

MINNESOTA:

Minnesota State Forestry Association.—President, Charles M. Loring, Minneapolis; secretary, George W. Strand, Taylors Falls.

NEBRASKA:

Nebraska Park and Forest Association, Lincoln.

NEW HAMPSHIRE:

Society for the Protection of New Hampshire Forests.—President, Hon. Frank W. Rollins, Concord; secretary, J. T. Walker, Concord.

NEW YORK:

New York State Fish, Game, and Forest League.—President, Robert B. Lawrence, 35 Wall street, New York; secretary, E. A. Gould, Seneca Falls.

NORTH CAROLINA:

North Carolina Forestry Association.—President, W. E. Petty, Seaboard Air Line; secretary, W. W. Ashe, Chapelhill.

NORTH DAKOTA:

North Dakota State Sylvaton Society.—Chief forester, W. W. Barrett, Churchs Ferry; secretary, Miss Mary G. Buck, Lakota.

OREGON:

Oregon Forestry Association.—President, William G. Steel, Portland; secretary, Martin W. Gorman, Portland.

Mazamas, The.—President, Mark O'Neill, Portland, Oreg.; secretary (corresponding), William G. Steel, Portland.

PENNSYLVANIA:

Pennsylvania Forestry Association.—President, John Birkinbine, 1012 Walnut street, Philadelphia; secretary, Dr. Joseph T. Rothrock, commissioner of forestry, Harrisburg; secretary (corresponding), Mrs. John P. Lundy, 245 South Eighteenth street, Philadelphia.

Franklin Forestry Society.—President, Alvin B. Kuhn; secretary, W. G. Bowers, Chambersburg, Pa.

UTAH:

Utah Forestry Association.—Prof. W. J. Roylance, Salt Lake City.

WASHINGTON:

Washington Forestry Association.—President, Prof. Edmund S. Meany, Seattle; secretary, Albert Bryan.

## SCHOOLS OF FORESTRY.

CONNECTICUT:

Yale Forest School, New Haven: A two-years graduate course. In connection with the Yale Forest School, a two-months summer course, July and August, is conducted at Milford, Pa. Prof. Henry S. Graves, Director.

NEW YORK:

New York State College of Forestry at Cornell University, Ithaca: Four-years course; practical instruction afforded by a demonstration area of 30,000 acres of State forest. Dr. B. E. Fernow, Director.

NORTH CAROLINA:

Biltmore School of Forestry, Biltmore: One-year course, comprising practical work in the forest, theoretical instruction, and forest research. No botany or other auxiliary sciences. Dr. C. A. Schenck, Director.

## INSTITUTIONS OFFERING INSTRUCTION IN FORESTRY.

ALABAMA:
State Agricultural and Mechanical College, Auburn: One term, two hours a week; lectures and occasional field work.

ARKANSAS:
Arkansas Industrial University, Fayetteville: One term, twice a week; with horticulture.

CALIFORNIA:
University of Southern California, Los Angeles: Full course.
University of California.

COLORADO:
The State Agricultural College of Colorado, Fort Collins: Portion of junior year in horticulture.

CONNECTICUT:
Storrs Agricultural College, Storrs: Junior and senior years.

GEORGIA:
Georgia State College of Agriculture and Mechanic Arts, Athens: Junior year in horticulture concludes with short course in forestry.

IDAHO:
College of Agriculture of the University of Idaho, Moscow: General practical course.

ILLINOIS:
College of Agriculture of the University of Illinois, Urbana: One term, twice a week; general.
English High and Manual Training School, Chicago: Ten lectures on forestry, lumbering, and wood in the first year.

INDIANA:
Purdue University, Lafayette: Elective in senior year; general instruction.

IOWA:
Iowa State College of Agriculture and Mechanic Arts, Ames.

KANSAS:
Kansas State Agricultural College, Manhattan: One term, three times a week; general instruction.

KENTUCKY:
Berea College, Berea: General instruction.
Ogden College, Bowling Green: Just introduced.
Probably also at the Agricultural and Mechanical College of Kentucky, Lexington.

MAINE:
The University of Maine, Orono: With horticulture and botany only.

MARYLAND:
Maryland Agricultural College, College Park: Only incidentally.

MASSACHUSETTS:
Massachusetts Agricultural College, Amherst: With horticulture.
Harvard University, Cambridge: Arboriculture taught.

MICHIGAN:
Michigan Agricultural College, Agricultural College: One term, three times a week, and daily lectures during half of another term; general instructlon.
State University, Ann Arbor: Some instruction.
State Normal School, Ypsilanti: Some instruction.

MINNESOTA:
College of Agriculture of the University of Minnesota, St. Anthony Park, St. Paul: Four times a week for two terms. Course 1, lectures covering general principles and Minnesota conditions. Course 2, lectures and field work; practical conditions.

MISSISSIPPI:
Mississippi Agricultural and Mechanical College, Agricultural College: Touched on in botany.

MISSOURI:
College of Agriculture and Mechanic Arts of the University of Missouri, Columbia: One semester, two hours a week; general instruction.

MONTANA:
The Montana College of Agriculture and the Mechanic Arts, Bozeman: Lectures and field work, with agriculture.

NEBRASKA:
The Industrial College of the University of Nebraska, Lincoln: One semester, twice a week; general instruction, including dendrology.

NEVADA:

School of Agriculture of the Nevada State University, Reno: One year, three hours a week; with horticulture.

NEW HAMPSHIRE:

New Hampshire College of Agriculture and the Mechanic Arts, Durham: One-year special course; also several shorter courses, including advanced course in theoretical and practical work.

NORTH CAROLINA:

The North Carolina College of Agriculture and Mechanic Arts, West Raleigh: One term, one hour a week; lectures only.

North Carolina State University, Chapelhill: Short course of lectures on forest conditions and need of management.

NORTH DAKOTA:

North Dakota Agricultural College, Agricultural College: Four weeks, five hours a week; confined chiefly to forest influences on climate and soil conditions.

OHIO:

Ohio State University, Columbus: One term, twice a week; general instruction.

OKLAHOMA:

Oklahoma Agricultural and Mechanical College, Stillwater: One term in connection with horticulture; general instruction, including demonstration on experiment station farm.

OREGON:

Oregon State Agricultural College, Corvallis: One term; optional in botany course.

PENNSYLVANIA:

University of Pennsylvania, Philadelphia: General course.

The Pennsylvania State College, State College: One term; lectures on general principles.

Other schools.

RHODE ISLAND:

Rhode Island College of Agriculture and Mechanic Arts, Kingston: One term, three times a week; elective in horticulture course.

SOUTH DAKOTA:

South Dakota Agricultural College, Brookings: Three to four hours a week; general instruction and field work.

TENNESSEE:

University of the South, Sewanee: General course.

TEXAS:

State Agricultural and Mechanical College of Texas, College Station: Ten weeks, twice a week; general instruction.

VERMONT:

University of Vermont and State Agricultural College, Burlington: One-half year, two hours a week; general instruction, with some field work.

WASHINGTON:

Washington Agricultural College and School of Science, Pullman: One semester; attenton chiefly devoted to plantations, with considerable field work.

University of Washington, Seattle: Some instruction.

WEST VIRGINIA:

West Virginia University, Morgantown: Twelve weeks, five times a week; lectures on general principles.

WISCONSIN:

College of Agriculture of the University of Wisconsin, Madison: One year, twice a week; general instruction.

WYOMING:

College of Agriculture of the University of Wyoming, Laramie: With horticulture.

## OFFICERS OF HORTICULTURAL AND KINDRED SOCIETIES.

NATIONAL AND REGIONAL SOCIETIES:

American Association of Nurserymen, 1901.—President, Theodore J. Smith, Geneva, N. Y.; vice-president, N. W. Hale, Knoxville, Tenn.; secretary, George C. Seager, Rochester, N. Y.; treasurer, C. L. Yates, Rochester, N. Y.

American Carnation Society, 1901.—President, Robert Halliday, Baltimore, Md.; vice-president, William Weber, Oakland, Md.; secretary, Albert M. Herr, Lancaster, Pa.; treasurer, Fred Dorner, jr., Lafayette, Ind.

American Cranberry Growers' Association, 1901.—President, E. H. Durell, Woodbury, N. J.; first vice-president, B. P. Wills, Mount Holly, N. J.; second vice-president, J. D. Holman, Whitesville, N. J.; secretary and treasurer, A. J. Rider, 3143 Mantua avenue, Philadelphia, Pa.

American Pomological Society, 1900–1901.—President, C. L. Watrous, Des Moines, Iowa; vice-president, Thomas Meehan, Germantown, Pa.; secretary, William A. Taylor, 55 Q street NE., Washington, D. C.; treasurer, L. R. Taft, Agricultural College, Michigan; chairman of the executive committee, Charles W. Garfield, Burton Farm, Grand Rapids, Mich.

American Rose Society, 1901.—President, Benjamin Dorrance, Dorrancetown, Pa.; vice-president, J. H. Taylor, Bayside, N. Y.; treasurer, John N. May, Summit, N. J.; secretary, Leonard Barron, 136 Liberty street, New York, N. Y.

Cider and Cider-Vinegar Association of the Northwest, 1901.—President, F. C. Johnson, Kishwaukee, Ill.; first vice-president, G. W. Hilliard, Brighton, Ill.; second vice-president, George Keightley, Clarksville, Mo.; secretary and treasurer, George Miltenberg, No. 213 North Second street, St. Louis, Mo.

Eastern Nurserymen's Association, 1901.—President, W. C. Barry, Rochester, N. Y.; vice-president, C. H. Hawks, Rochester, N. Y.; secretary and treasurer, William Pitkin, Rochester, N. Y.

Missouri Valley Horticultural Society, 1901.—President, Homer Reed, Tenth and Broadway, Kansas City, Mo.; vice-president, W. L. Cellar, Edwardsville, Kans.; secretary, A. Chandler, Argentine, Kans.; treasurer, G. F. Espenlaub, Rosedale, Kans.

National Apple Shippers' Association, 1901.—President, G. C. Richardson, Leavenworth, Kans.; vice-president, C. P. Rothwell, East Palestine, Ohio; secretary, A. Warren Patch, Boston, Mass.; treasurer, William L. Wagner, Chicago, Ill.; statistician, B. W. Snow, Chicago, Ill.

Northwest Fruit Growers' Association, 1901.—President, Dr. N. G. Blalock, Walla Walla, Wash.; vice-presidents, L. A. Porter, Lewiston, Idaho; E. L. Smith, Hood River, Oreg.; Frank L. Wheeler, North Yakima, Wash.; J. R. Anderson, Victoria, British Columbia; secretary, C. L. Vanderwater, Walla Walla, Wash.; treasurer, W. S. Offner, Walla Walla, Wash.

Peninsula Horticultural Society, 1901.—President, Orlando Harrison, Berlin, Md.; vice-president, A. N. Brown, Wyoming, Del.; secretary-treasurer, Wesley Webb, Dover, Del.

Society of American Florists and Ornamental Horticulturists, 1901.—President, Patrick O'Mara, Jersey City, N. J.; vice-president, W. F. Kasting, Buffalo, N. Y.; secretary, William J. Stewart, Boston, Mass.; treasurer, H. N. Beatty, Oil City, Pa.

Western Association of Wholesale Nurserymen, 1901.—President, A. L. Brooke, North Topeka, Kans.; vice-president, R. H. Blair, Kansas City, Mo.; secretary and treasurer, E. J. Holman, Leavenworth, Kans.

Southern Nurserymen's Association.—President, N. W. Hale, Knoxville, Tenn.; secretary, W. Lee Wilson, Winchester, Tenn.

State Societies, 1901:

Arkansas State Horticultural Society.—President, John P. Logan, Silversprings; vice-president, S. H. Nowlin, Little Rock; secretary, W. K. Tipton, Little Rock; treasurer, Joseph Vestal, Little Rock.

California State Floral Society, 1901.—President, Emory E. Smith, Paloalto; secretary, Mrs. H. P. Tricou, San Francisco.

Colorado State Horticultural Society, 1901.—President, W. S. Coburn, Hotchkiss; secretary, W. B. Osborn, Denver.

Connecticut Pomological Society, 1901.—President, J. H. Merriman, New Britain; vice-president, G. S. Butler, Cromwell; secretary, H. C. C. Miles, Milford; treasurer, R. A. Moore, Kensington.

Connecticut Horticultural Society, 1901.—President, George S. Osborn, Hartford; secretary, L. H. Mead, Hartford.

Florida State Horticultural Society, 1901.—President, G. L. Taber, Glen St. Mary; secretary, Stephen Powers, Jacksonville; treasurer, W. S. Hart, Hawks Park.

Georgia Horticultural Society, 1901.—President, P. J. Berckmans, Augusta; vice-president, first district, G. M. Ryals, Savannah; secretary, G. H. Miller, Rome; treasurer, Louis A. Berckmans, Augusta.

Idaho State Horticultural Society, 1901.—President, I. B. Perrine, Shoshone Falls; vice-president, F. A. Huntley, Moscow; secretary, Robert Milliken, Nampa; treasurer, R. M. Groiner, Caldwell.

Illinois State Horticultural Society, 1901.—President, Henry M. Dunlap, Savoy; vice-president, William A. Young, Butler; secretary, L. R. Bryant, Princeton; treasurer, J. W. Stanton, Richview.

Indiana Horticultural Society, 1901.—President, C. M. Hobbs, Bridgeport; secretary, James Troop, Lafayette; treasurer, Silvester Johnson, Irvington.

Iowa State Horticultural Society, 1901.—President, M. J. Wragg, Waukee; vice-president, N. K. Fluke, Davenport; secretary, Wesley Greene, Des Moines; treasurer, Elmer Reeves, Waverly.

Kansas State Horticultural Society, 1901.—President, Fred Wellhouse, Topeka;

vice-president, J. W. Robison, Eldorado; secretary, William H. Barnes, Topeka; treasurer, Frank Holsinger, Rosedale; entomologist, E. A. Popenoe, Manhattan.

Kentucky State Horticultural Society, 1901.—President, M. F. Johnson, Ferncreek; secretary, J. C. Hawes, Ferncreek.

Maine State Pomological Society, 1901.—President, C. A. Arnold, Arnold; first vice-president, Z. A. Gilbert, North Greene; second vice-president, D. P. True, Leeds Center; secretary, D. H. Knowlton, Farmington; treasurer, C. S. Pope, Manchester.

Maryland State Horticultural Society, 1901.—President, James S. Harris, Coleman; vice-president, N. F. Flitton, Baltimore; secretary and treasurer, H. P. Gould, College-park.

Massachusetts Fruit Growers' Association, 1900.—President, H. O. Mead, Lunenburg; vice-president, A. G. Sharpe, Richmond; secretary, C. A. Whitney, Upton; treasurer, Ethan Brooke, West Springfield.

Massachusetts Horticultural Society, 1901.—President, O. B. Hadwen, Worcester; vice-president, Walter Hunnewell, Boston; secretary, Robert Manning, 101 Tremont street, Boston; treasurer, Charles E. Richardson, 101 Tremont street, Boston.

Michigan State Horticultural Society, 1901.—President, R. M. Kellogg, Three Rivers; vice-president, R. J. Coryell, Detroit; secretary, C. E. Bassett, Fennville; treasurer, Asa W. Slayton, Grand Rapids.

Minnesota State Horticultural Society, 1901.—President, W. W. Pendergast, Hutchinson; vice-president, Jonathan Freeman, Austin; secretary, A. W. Latham, 207 Kasota Block, Minneapolis; treasurer, H. M. Lyman, Excelsior.

Missouri State Horticultural Society, 1901.—President, N. F. Murray, Oregon; vice-president, D. A. Robnett, Columbia; secretary, L. A. Goodman, 4000 Warwick avenue, Kansas City; treasurer, A. Nelson, Lebanon.

Montana State Horticultural Society, 1901.—President, S. M. Emery, Bozeman; secretary and treasurer, C. H. Edwards, Missoula.

Nebraska State Horticultural Society, 1901.—President, George A. Marshall, Arlington; vice-president, L. M. Russell, Wymore; secretary, C. H. Barnard, Tablerock; treasurer, Peter Youngers, jr., Geneva.

New Hampshire State Horticultural Society, 1901.—President, C. C. Shaw, Milford; vice-president, J. W. Farr, Littleton; secretary, W. D. Baker, Quincy; treasurer, T. E. Hunt, Lakeport.

New Jersey State Horticultural Society, 1901.—President, Henry E. Hale, Princeton; vice-president, William H. Reid, Tennent; secretary, Henry I. Budd, Mount Holly; treasurer, Ira J. Blackwell, Titusville.

New Mexico State Horticultural Society, 1901.—President, L. Bradford Prince, Santa Fe; vice-president, W. S. Harroun, Santa Fe; secretary, Jose D. Sena, Santa Fe; treasurer, Soloman Spiegelberg, Santa Fe.

New York Fruit Growers' Association, 1901.—President, L. T. Yeomans, Walworth; vice-presidents, John T. Roberts, Onondaga, and John Potter, Niagara; secretary, F. E. Dawley, Fayetteville; treasurer, Charles H. Darrow, Geneva.

North Carolina State Horticultural Society, 1901.—President, J. Van. Lindley, Pomona; vice-president, W. F. Massey, Raleigh; secretary and treasurer, Franklin Sherman, Agricultural Department, Raleigh.

Ohio State Horticultural Society, 1901.—President, William Miller, Gypsum; vice-president, W. N. Scarff, New Carlisle; secretary, W. W. Farnsworth, Waterville; treasurer, N. Ohmer, Dayton.

Oregon State Horticultural Society, 1901.—President, Dr. J. R. Cardwell, Portland; first vice-president, William Galloway, Oregon City; second vice-president, H. M. Williamson, Portland; secretary and treasurer, E. R. Lake, Corvallis.

Pennsylvania Horticultural Society, 1901.—President, James M. Rhodes, Third and Chestnut streets, Philadelphia; vice-president, Dr. George Gobel, 1601 Columbia avenue, Philadelphia; secretary, David Rust, Horticultural Hall, Philadelphia; treasurer, Sidney W. Keith, Land Title Building, Philadelphia.

Pennsylvania State Horticultural Association, 1901.—President, Howard A. Chase, 1430 South Penn square, Philadelphia; vice-presidents, Calvin Cooper, Bird-in-hand, Wm. T. Creasy, Catawissa, M. C. Dunlevy, Carnegie; secretary, E. B. Engle, Waynesboro; corresponding secretary, W. T. Brinton, Christiana; treasurer, Samuel C. Moon, Morrisville.

Rhode Island Horticultural Society, 1901.—President, J. E. C. Farnham, Providence; vice-presidents, R. H. I. Goddard, Providence; Royal C. Taft, Providence; Joseph D. Litts, Providence; secretary and treasurer, Charles W. Smith, 61 Westminster street, Providence.

South Dakota State Horticultural Society, 1901.—President, H. M. Avery, Sioux Falls; vice-president, A. Norby, Madison; secretary, N. E. Hansen, Brookings; treasurer, M. J. De Wolf, Letcher; librarian, E. D. Cowles, Vermilion.

Texas State Horticultural Society, 1901.—President, F. W. Mally, College Station;

vice-presidents, B. L. Adams, Bonham, and E. Mixer, Richards, La.; secretary and treasurer, Samuel H. Dixon, Houston.

Vermont Horticultural Society, 1901.—President, Arthur H. Hill, Isle Lamotte; secretary and treasurer, D. C. Hicks, North Clarendon.

Virginia State Horticultural Society, 1901.—President, Samuel B. Woods, Charlottesville; vice-president, George E. Murrell, Fontella; recording secretary, H. B. Dinwidie, Glenwood Depot; corresponding secretary and treasurer, Walter Whately, Crozet.

West Virginia State Horticultural Society, 1901.—President, R. C. Burkhart, Martinsburg; vice-president, O. V. Oshel, Grimms Landing; secretary, L. C. Corbett, Morgantown.

Wisconsin State Horticultural Society, 1901.—President, T. E. Loope, Eureka; vice-president, F. C. Edwards, Fort Atkinson; secretary, J. L. Herbst, Sparta; treasurer, L. G. Kellogg, Ripon.

Wisconsin State Cranberry Growers' Association, 1901.—President, Charles Brieres, Grand Rapids; vice-president, S. N. Whittlesey, Cranmoor; secretary, W. H. Fitch, Cranmoor; treasurer, Melvin Potter, Centralia.

Officers and Members of State Boards of Horticulture:

California State Board of Horticulture, 1901.—President, Ellwood Cooper, Santa Barbara; vice-president, Frank H. Buck, Vacaville; secretary and chief horticultural officer, B. M. Lelong, Sacramento; treasurer, William B. Gester, Newcastle; auditor, R. D. Stephens, Sacramento; quarantine officer and entomologist, Alexander Craw, Sacramento; district commissioners, Thomas A. Rice, H. Weinstock, Benjamin M. Maddox, A. Block, W. T. Hotchkiss.

Colorado State Board of Horticulture, 1901.—President, W. S. Coburn, Hotchkiss; secretary, W. B. Osborn, Loveland; members, J. H. Crowley, Rockyford; David Brothers, Denver; Martha A. Shute, Denver; J. R. Penniston, Whitewater.

Indiana State Board of Horticulture, 1901.—President, C. M. Hobbs, Bridgeport; vice-presidents, Mrs. W. W. Stevens, George P. Campbell, Amos Garretson, J. C. Grossman; secretary, J. Troop, Lafayette; treasurer, Silvester Johnson, Irvington; executive committee, E. Y. Teas, L. B. Custer, Joe A. Burton.

Montana State Board of Horticulture, 1901.—President, I. D. O'Donnell, Billings; secretary, C. H. Edwards, Missoula; district committeemen, S. M. Emery, C. H. Campbell, D. E. Bandmann, J. H. Edwards; ex officio, Governor Joseph K. Toole, Helena.

Oregon State Board of Horticulture, 1901.—President, E. L. Smith, Hood River; secretary, Henry E. Dosch; treasurer, Lloyd T. Reynolds; commissioners, Wilbur K. Newell, Lloyd T. Reynolds, A. H. Carson, Emile Schanno, and Judd Geer.

Utah State Board of Horticulture, 1901.—President, Thomas Judd; vice-president, H. E. Carey; secretary, J. A. Wright, Ogden.

Local Horticultural Societies:

Southern California Pomological Society, 1901.—President, S. M. Woodbridge, South Pasadena; vice-president, D. Edson Smith, Santa Ana; secretary and treasurer, James Boyd, Riverside.

North Georgia Fruit Growers' Institute, 1901.—President, G. H. Miller, Rome; secretary and treasurer, G. R. Casey, Adairsville.

Horticultural Society of Central Illinois, 1901.—President, H. Augustine, Normal; vice-president, G. J. Foster, Bloomington; secretary, J. C. Blair, Champaign.

Horticultural Society of Northern Illinois, 1901.—President, J. L. Hartwell, Dixon; vice-president, H. L. Thompson, Marengo; secretary, Jacob Friend, Nekoma; treasurer, L. Woodward, Marengo.

Horticultural Society of Southern Illinois, 1901.—President, J. W. Stanton, Richview; vice-president, H. A. Aldrich, Neoga; secretary and treasurer, E. G. Mendenhall, Kinmundy.

Northeastern Iowa Horticultural Society, 1901.—President, Elmer Reeves, Waverly; vice-president, J. B. Mitchell, Cresco; secretary, Charles H. True, Edgewood; treasurer, G. A. Ivins, Iowa Falls.

Northwestern Iowa Horticultural Society, 1901.—President, P. F. Kinne, Storm Lake; vice-president, J. C. Winset, Fostoria; treasurer, Ben Shontz, Correctionville; secretary, W. B. Chapman, Washta.

Southeastern Iowa Horticultural Society, 1901.—President, W. T. Richey, Albia; vice-president, R. E. Hines, Ottumwa; secretary, C. W. Burton, Cedar Rapids; treassurer, F. O. Harrington, York Center.

Southwestern Iowa Horticultural Society, 1901.—President, J. P. Jackson, Glenwood; vice-president, J. H. M. Edwards, Logan; secretary, W. M. Bomberger, Harlan; treasurer, O. H. Barnhill, Shenandoah.

Horticultural Association of Western Maryland, 1901.—President, Charles C. Biggs, Sharpsburg; vice-president, Caleb Long, Downsville; secretary and treasurer, Arthur L. Towson, Smithburg.

Cape Cod Cranberry Growers' Association, 1901.—President, Emulus Small, Harwickport; secretary and treasurer, Franklin Crocker, Hyannis.

West Michigan Horticultural Society, 1901.—President, R. M. Kellogg, Three Rivers; secretary, C. A. French, Grand Rapids; treasurer, A. Hamilton, Bangor.

Southern Minnesota Horticultural Society, 1901.—President, J. C. Hawkins, Austin; vice-presidents, E. F. Peck, Austin, O. W. Moore, Spring Valley; secretary and treasurer, Robert Parkhill, Chatfield.

Central Missouri Horticultural Association, 1901.—President, D. F. Nixon, Harriston; vice-president, D. Edwards, Boonville; secretary, C. C. Bell, Boonville; treasurer, W. A. Smiley, Boonville.

South Missouri Horticultural Association, 1901.—President, D. J. Nichols, Westplains; secretary and treasurer, J. T. Snodgrass, Westplains.

Eastern New York Horticultural Society, 1901.—President, Geo. T. Powell, Briarcliff Manor; vice-president, W. F. Taber, Poughkeepsie; secretary and treasurer, Chas. H. Royce, Briarcliff.

Western New York Horticultural Society, 1901.—President, W. C. Barry, Rochester; vice-presidents, S. D. Willard, Geneva, J. S. Woodward, Lockport, Albert Wood, Carlton Station, T. B. Wilson, Halls Corner; secretary and treasurer, John Hall, Rochester.

West Tennessee Horticultural Society, 1901.—President, J. W. Rosaman, Gadsden; vice-president, L. C. James, Gibson; secretary and treasurer, J. D. Johnson, Henderson.

East Tennessee Horticultural Society.—President, Chas. A. Keffer, Knoxville; secretary and treasurer, H. Lightfoot, Chattanooga.

## NATIONAL, SECTIONAL, AND STATE BEE KEEPERS' ASSOCIATIONS.

UNITED STATES:

National Bee Keepers' Association.—President, E. R. Root, Medina, Ohio; secretary, A. B. Mason, Toledo, Ohio; general manager and treasurer, Eugene Secor, Forest City, Iowa.

CALIFORNIA:

California State Bee Keepers' Association.—President, R. Wilkin, Ventura; secretary and treasurer, J. F. McIntyre, Sespe.

The California Bee Keepers' Association.—President, Dr. J. P. Johnson, Fresno; secretary, Prof. C. S. Taylor, Selma; corresponding secretary, O. L. Abbott, Selma.

COLORADO:

Colorado Honey Producers' Association.—President, W. L. Porter, Denver; secretary, Frank Rauchfuss, Denver.

Colorado State Bee Keepers' Association.—President, R. C. Aikin, Loveland; secretary, D. W. Working, Denver.

Northern Colorado Bee Keepers' Association.—President, A. F. Foster, Boulder; secretary and treasurer, H. C. Morehouse, Boulder.

CONNECTICUT:

Connecticut Bee Keepers' Association.—Secretary, Miss Ellen B. Peck, Clinton.

ILLINOIS:

Illinois State Bee Keepers' Association.—President, J. Q. Smith, Lincoln; secretary, James A. Stone, R. R. 4, Springfield.

Northern Illinois Bee Keepers' Association.—President, N. A. Kluck, McConnell; secretary, B. Kennedy, Rockford.

INDIANA:

Indiana State Bee Keepers' Association.—President, E. S. Pope, Indianapolis; secretary, W. S. Pouder, Indianapolis.

IOWA:

Eastern Iowa Bee Keepers' Association.—Secretary, W. A. Hay, Anamosa.

KANSAS:

Southeastern Kansas Bee Keepers' Association.—President, J. P. Ralston, Uniontown; secretary, J. C. Balch, Bronson.

MICHIGAN:

Michigan State Bee Keepers' Association.—President, George E. Hilton, Fremont; secretary, William G. Voorheis, South Frankfort.

North Michigan Bee Keepers' Association.—E. E. Coveyou, Petoskey.

MINNESOTA:

Minnesota Bee Keepers' Association.—President, J. P. West, Hastings; secretary, L. D. Leonard, Minneapolis.

Southern Minnesota Bee Keepers' Association.—President, E. B. Huffman, Homer; secretary, C. A. Giles, Winona.

NEBRASKA:

Nebraska Bee Keepers' Association.—President, E. Whitcomb, Friend; secretary, L. D. Stilson, York.

NEW YORK:

New York State Association of Bee Keepers' Societies.—President, W. F. Marks, Chapinville; secretary-treasurer, C. B. Howard, Romulus.

New York State Bee Keepers' Association.—President, I. L. Scofield, Chenango Bridge; secretary, J. H. Knickerbocker, Pleasant Valley.

OHIO-PENNSYLVANIA:

Northeastern Ohio and Northwestern Pennsylvania Bee Keepers' Association.—Secretary, Ed. Jolley, Franklin, Pa.

SOUTH DAKOTA:

South Dakota State Bee Keepers' Association.—President, Thomas Chantry, Meckling; general manager, J. J. Duffack, Yankton; secretary, E. F. Atwater, Yankton.

TENNESSEE:

Southern East Tennessee Bee Keepers' Association.—President, M. T. Fouts, Parksville; secretary, W. J. Copeland, Fetzerton.

TEXAS:

Central Texas Bee Keepers' Association.—President, J. B. Salyer, Jonah; secretary, Louis Scholl, Hunter.

South Texas Bee Keepers' Association.—President, G. W. Huffstedler, Beeville; secretary, E. J. Atchley, Beeville.

Texas State Bee Keepers' Association.—President, W. R. Graham, Greenville; secretary and treasurer, J. N. Hunter, Leonard.

UTAH:

Utah Bee Keepers' Association.—President, E. S. Lovesy, Salt Lake City; secretary and treasurer, J. B. Fagg, Millcreek.

VERMONT:

Vermont Bee Keepers' Association.—Secretary, M. F. Cram, West Brookfield.

WASHINGTON:

Washington State Bee Keepers' Association.—Secretary, L. R. Freeman, North Yakima.

WISCONSIN:

Southwestern Wisconsin Bee Keepers' Association.—President, N. E. France, Platteville; secretary, F. L. Murray, Calamine.

Wisconsin State Bee Keepers' Association.—President, N. E. France, Platteville; secretary, Miss Ada L. Pickard, Richland Center.

## MISCELLANEOUS STATE ORGANIZATIONS.

Illinois Seed Corn Growers' Association.—Secretary, F. A. Warner, Sibley.

New York State Farmers' Congress.—Secretaries, G. L. Flanders and E. A. Callahan, Albany.

New York State Fair.—Secretary, S. C. Shaver, Albany.

Nebraska Sugar Beet Growers' Association.—Secretary, W. N. Nason, Omaha.

Nebraska Veterinary Medical Association.—Secretary, A. T. Peters, Lincoln.

Nebraska Irrigation Association.—Secretary, Robert Oberfelder, Sidney.

Texas Truck Growers' Association.—Secretary, J. G. Jones, San Antonio.

Texas Cotton Growers' Association.—President, E. S. Peters, Calvert.

## THE NATIONAL GOOD ROADS ASSOCIATION.

President, W. H. Moore; secretary, R. W. Richardson; treasurer, Edwin A. Potter. Address for general officers, 928–29 Marquette Building, Chicago, Ill.

*Vice-presidents of association.*

| State. | Vice-president. | Post-office. |
|---|---|---|
| California | J. Baruch | Los Angeles. |
| Colorado | W. H. Wadley | Denver. |
| Illinois | Gus M. Greenebaum | Danville. |
| Iowa | G. H. Van Houten | Des Moines. |
| Idaho | W. E. Pierce | Boise. |
| Kansas | Wm. Bradbury | Topeka. |
| Kentucky | I. B. Nall | Frankfort. |
| Maryland | Wm. D. Clark | Johns Hopkins, Baltimore. |
| Michigan | A. E. Palmer | |
| Minnesota | Geo. W. Cooley | Minneapolis. |
| Montana | Samuel Fortier | |
| Missouri | H. R. Whitmore | St. Louis. |
| Nebraska | G. R. Williams | Elk City. |
| New Jersey | Henry I. Budd | Trenton. |
| New York | John B. Weber | Buffalo. |
| North Carolina | J. A. Holmes | Chapelhill. |
| Ohio | J. W. Stewart | Cleveland. |
| South Carolina | E. S. Tessier, jr | Charleston. |
| Washington | J. A. James | Seattle. |
| Wisconsin | G. N. Fratt | Racine. |

### STATE GOOD ROADS ASSOCIATIONS.

Florida.—Secretary, J. W. White, Jacksonville.
Kansas.—Secretary, Robert Stone, Topeka.

## THE PROTECTION OF BIRDS AND GAME.

### STATE OFFICIALS.

ARIZONA:

*Fish and game commissioners* (commission established 1887; term, two years).—T. S. Bunch, Flagstaff; W. L. Pinney, Phoenix; Jean Allison, Jerome (terms expire 1903).

CALIFORNIA:

*Board of fish commissioners*[1] (established ——; term, during pleasure of governor).—President, Alexander T. Vogelsang, Mills Building, San Francisco; W. W. Van Arsdale, Crocker Building, San Francisco; H. W. Keller, Santa Monica; chief deputy, John P. Babcock, San Francisco.

COLORADO:

*Game and fish commission* (established 1891; term, two years).—Commissioner, Charles W. Harris, 35 Capitol Building, Denver; chief wardens, first district, Frank Fenn, Denver; second district, James Lyttle, Meeker; third district, W. A. Lee. Glenwood Springs; fourth district, B. F. Jay, Grand Junction; fifth district, E. H, Norton, Montrose.

CONNECTICUT:

*Commission of fisheries and game* (established April 30, 1895; term, two years).—President, George T. Mathewson, Thompsonville; E. Hart Geer, Hadlyme; secretary, Robert G. Pike, Middletown (all terms expire July 1, 1903).

IDAHO:

*Fish and game warden* (office established 1899; term, two years).—T. W. Bartley, Moscow (term expires March 1, 1903).

ILLINOIS:

*State game commissioner* (office established 1899; term, incumbency of governor).—Henry W. Loveday, Springfield; suboffice, 1403 Schiller Building, Chicago.

INDIANA:

*Commissioner of fisheries and game* (office established February 13, 1899; term, four years).—Z. T. Sweeney, Columbus (term expires February 13, 1903).

[1] Has jurisdiction over matters relating to game.

IOWA:

*Fish and game warden* (office established 1897; term, three years).—G. A. Lincoln, Cedar Rapids (term expires March 31, 1904).

MAINE:

*Commissioners of inland fisheries and game* (commission established 1880; term three years).—Chairman, L. T. Carleton, Augusta (term expires April 20, 1902); Henry O. Stanley, Dixfield (term expires Feb. 1, 1902); Charles E. Oak, Caribou (term expires Jan. 29, 1904).

MARYLAND:

*Game warden* (office established April 4, 1896; term, two years).—Jno. W. Avirett, Cumberland (term expires April 1, 1902).

*Chief of deputy game wardens.*—Robert H. Gilbert, Calvert and Lombard streets, Baltimore.

MASSACHUSETTS:

*Commissioners of inland fisheries and game* (commission established 1865; jurisdiction extended to game, 1886; term, five years).—Chairman, Joseph W. Collins, Boston; (term expires 1904); secretary, Edward A. Brackett, Winchester; John W. Delano, Marion (term expires December 5, 1905).

MICHIGAN:

*Game and fish warden department* (established 1887; term, four years).—Warden, Grant M. Morse, Portland (term expires January 28, 1903); chief deputy, Charles E. Brewster, Portland.

MINNESOTA:

*Game and fish commissioners* (board established 1891; term, two years).—President, Uri L. Lamprey, St. Paul; vice-president, W. P. Hill, Fairmont; secretary, D. W. Meeker, Moorhead; treasurer, H. G. Smith, Winona; executive agent, S. F. Fullerton, St. Paul. All terms expire January, 1903.

MISSOURI:

*Game and fish warden* (office established 1895; term, two years).—A. J. D. Burford, Burfordville (term expires June 28, 1901).

MONTANA:

*State game and fish warden* (office established 1901).—William F. Scott, Helena.

NEW HAMPSHIRE:

*Fish and game commission* (established 1869; term, five years).—Chairman, N. Wentworth, Hudson Center; financial agent, W. H. Shurtleff, Lancaster; secretary, F. L. Hughes, Ashland.

NEW JERSEY:

*Fish and game commission* (established Mar. 22, 1895).—President and treasurer, Howard P. Frothingham, Mount Arlington; William A. Halsey, Newark; Benj. P. Morris, Long Branch; Richard T. Miller, Camden; fish and game protector, George Riley, 190 Broad street, Newark.

NEW YORK:

*Forest, fish, and game commission* (established 1895; reorganized 1901).—President, Timothy L. Woodruff, Brooklyn (term expires 1903); De Witt C. Middleton, Watertown (term expires1905); Charles H. Babcock, Rochester (term expires 1903); chief game protector, J. Warren Pond, Albany.

NORTH DAKOTA:

*State game warden* (office established 1895; term, two years).—Ever Wagness, Devils Lake (term expires April 1, 1903).

OHIO:

*Commissioners of fish and game* (commission established 1886; term, five years).—President, George Falloon, Athens (term expires May 17, 1901); J. C. Burnett, Sabina (term expires May 17, 1902); Albert Brewer, Tiffin (term expires May 17, 1903); Charles E. Buroker, St. Paris (term expires May 17, 1904); A. J. Hazlett, Bucyrus (term expires May 17, 1905); secretary and chief warden, L. H. Reutinger, Athens (term expires August 1, 1901).

OKLAHOMA:

*Game and fish warden* (office established March 10, 1899; term, four years).—C. M. Keiger, Jefferson, Grant County.

OREGON:

*Game and forestry warden* (office established 1899; term, four years).—L. P. W. Quimby, Portland (term expires 1902).

PENNSYLVANIA:

*Board of game commissioners* (board established June 25, 1895; term, three years).—President, William M. Kennedy, Allegheny City; C. K. Sober, Lewisburg; James H. Worden, Harrisburg; E. B. Westfall, Williamsport; Dr. Charles B. Penrose, Philadelphia; J. O. H. Denney, Ligonier; secretary, Dr. Joseph Kalbfus, Harrisburg.

RHODE ISLAND:

*Commissioners of birds* (commission established June, 1899; term, three years).—Chairman, Dr. F. H. Peckham, jr., Providence; Dr. E. R. Lewis, Westerly, Washington County; William H. Thayer, Bristol, Bristol County; A. O'D. Taylor, 11 Francis street, Newport; secretary, Thomas W. Penney, Olneyville, Kent County. All terms expire June 23, 1902.

UTAH:

*State fish and game commissioner* (office established 1899; term, two years).—John Sharp, Salt Lake City.

VERMONT:

*Fish and game commissioners* (commission established November 22, 1892; term, four years).—John W. Titcomb, St. Johnsbury (term expires November 30, 1902); E. A. Davis, Bethel (term expires November 30, 1904).

WASHINGTON:

*Fish commissioner and game warden* (office of warden established 1899; term, four years).—A. C. Little, 210–212 Berlin Building, Tacoma (term expires May 1, 1901).

WEST VIRGINIA:

*Game and fish warden* (office established 1897; term, four years).—E. F. Smith, Hinton (term expires March 4, 1905).

WISCONSIN:

*Fish and game warden* (office established 1891; term, two years).—James T. Ellarson, Madison (term expires May 1, 1901).

WYOMING:

*Game warden* (office established 1899; term, four years).—Albert Nelson, Grovont (term expires February 18, 1903).

BRITISH COLUMBIA:

*Provincial police department.*[1]—Superintendent, F. S. Hussey, Victoria.

MANITOBA:

*Chief game warden.*—W. M. Ingram, Winnipeg.

NEW BRUNSWICK:

*Crown land department.*[1]—Surveyor-general, A. T. Dunn, Fredericton; chief game commissioner, L. B. Knight, St. John; commissioner of fisheries, D. G. Smith, Chatham.

NEWFOUNDLAND:

*Department of marine and fisheries*[1] (established March 10, 1898).—Minister, G. J. Murphy, St. Johns; deputy minister, E. C. Watson, St. Johns; secretary, Moses Harvey, St. Johns.

NOVA SCOTIA:

*Nova Scotia game and inland fishery protection society.*—President, Colonel Clerke, Halifax; vice-presidents, H. N. Wallace, L. G. Power, Halifax; secretary, George Piers, Halifax; chief game commissioner, C. S. Harrington; commissioners, A. O. Pritchard, New Glasgow; Donald Ross, Margaree, Cape Breton Island; W. S. Crooker, Queens County; Albert Bigney, Cumberland.

ONTARIO:

*Fish and game commission* (established 1891; term, three years).—Dr. G. A. MacCallum, Dunnville (chairman); W. B. Wells, Chatham; H. S. Osler, Toronto; William Henry Casement, Lakefield; William Henry Biggar, Belleville; chief game warden, E. Tinsley, Parliament Building, Toronto.

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[1] Has jurisdiction over matters relating to protection of game.

QUEBEC:

*Department of lands, forests, and fisheries—Fisheries and game branch.*—Commissioner, S. N. Parent; assistant commissioner, E. E. Faché; general superintendent, L. Z. Joncas; inspector, H. de Puyjalon, Quebec; provincial game keepers, N. E. Cormier, Aylmer East; Joseph Riendeau, Montreal.

## NATIONAL ORGANIZATIONS.

AMERICAN ORNITHOLOGISTS' UNION—COMMITTEE ON PROTECTION OF NORTH AMERICAN BIRDS (established October 1, 1884):

Chairman, Witmer Stone, Academy Natural Sciences, Philadelphia, Pa.; William Dutcher, 525 Manhattan avenue, New York, N. Y.; T. S. Palmer, Department of Agriculture, Washington, D. C.; A. H. Thayer, Scarboro, N. Y.; Ruthven Deane, 24 Michigan avenue, Chicago, Ill.; E. H. Forbush, 17 Russell street, Malden, Mass.; J. Merton Swain, 319 Commercial street, Portland, Me.; Jas. Haynes Hill, New London, Conn.; F. C. Kirkwood, 1500 Bolton street, Baltimore, Md.; Prof. M. J. Elrod, University of Montana, Missoula, Mont.; Prof. George E. Beyer, Tulane University, New Orleans, La.; Frank Bond, 822 East Nineteenth street, Cheyenne, Wyo.; Mrs. Louise McGowen Stephenson, Helena, Ark.; William L. Baily, 423 Chestnut street, Philadelphia, Pa.; O. Widmann, Old Orchard, Mo.; W. Otto Emerson, Haywards, Cal.; Mrs. Florence Merriam Bailey, Washington, D. C.; Mrs. Edward Robins, 114 South Twenty-first street, Philadelphia, Pa.; Mrs. Olive Thorne Miller, 628 Hancock street, Brooklyn, N. Y.; Leverett M. Loomis, California Academy Sciences, San Francisco, Cal.; A. W. Anthony, 761½ Savier street, Portland, Oreg.; William Palmer, United States National Museum, Washington, D. C.

BIRD PROTECTIVE SOCIETY OF AMERICA (organized June 12, 1900):

President, Miss Clara Van Duzee, Hamburg, N. Y.
Secretary, Edward C. Pease, 28 Stafford Building, Buffalo, N. Y.

BOONE AND CROCKETT CLUB (founded December, 1887):

(Among the objects of the club are: Preservation of the large game of this country, to further legislation for that purpose, and to assist in enforcing existing laws.)

President, W. A. Wadsworth, Geneseo, N. Y.
Secretary and treasurer, C. Grant La Farge, 5 Beekman street, New York City.

INTERNATIONAL FOREST, FISH, AND GAME ASSOCIATION (organized 1900):

President, James H. Eckels, Chicago.
Secretary, John R. Hoagland, 221 Michigan avenue, Chicago.

LEAGUE OF AMERICAN SPORTSMEN (organized January 18, 1898; incorporated June 1, 1898):

President, G. O. Shields, 23 West Twenty-fourth street, New York, N. Y.
Secretary, Arthur F. Rice, 155 Pennington avenue, Passaic, N. J.
Chief wardens of State divisions:
Arizona—M. J. Foley, Jerome.
California—Dr. David Starr Jordan, Stanford University.
Colorado—A. Whitehead, 17 Bank Block, Denver.
Connecticut—F. P. Sherwood, Southport.
District of Columbia—Chas. H. Townsend, U. S. Fish Commission, Washington.
Idaho—T. W. Bartley, Boise.
Illinois—G. L. Lehle, 810 Schiller Building, Chicago.
Indiana—F. L. Littleton, 30½ East Washington street, Indianapolis.
Iowa—F. W. Bicknell, Des Moines.
Kansas—C. E. Sawyer, Wichita.
Maine—Gen. John T. Richards, Gardiner.
Massachusetts—Heman S. Fay, Hazleton Block, Marlboro.
Michigan—J. Elmer Pratt, 341 College avenue, Grand Rapids.
Minnesota—Dietrich Lange, 937 York street, St. Paul.
Missouri—Bryan Snyder, 726 Central Building, St. Louis.
Montana—Prof. M. J. Elrod, Missoula.
Nebraska—J. H. Ager, 1604 F street, Lincoln.
Nevada—W. W. Coleman, Carson City.
New Hampshire—E. W. Wild, Keene.
New Jersey—A. W. Van Saun, Pompton Plains.
New York—A. E. Pond, 148 Fifth avenue, New York.
Ohio—L. H. Reutinger, Athens.
Oregon—Robert F. Kelly, Box 188, The Dalles.
Pennsylvania—C. F. Emerson, 189 North Perry street, Titusville.
Rhode Island—Zenas W. Bliss, 49 Westminster street, Providence.

LEAGUE OF AMERICAN SPORTSMEN, ETC.—Continued.
Chief wardens of State divisions—Continued.
South Dakota—Burdett Moody, Lead.
Tennessee—G. C. Martin, Brooksville.
Texas—Prof. S. W. Stanfield, San Marcos.
Utah—John Sharp, Salt Lake City.
Vermont—W. E. Mack, Woodstock.
Virginia—Franklin Stearns, 13 North Eleventh street, Richmond.
Washington—F. S. Merrill, Spokane.
West Virginia—J. M. Lashley, Davis.
Wisconsin—James T. Drought, Milwaukee.
Wyoming—Dr. Frank Dunham, Lander.
Ontario—C. A. Hammond, Box 701, St. Thomas.

NATIONAL GAME, BIRD, AND FISH PROTECTIVE ASSOCIATION:
President, A. L. Lakey, Kalamazoo, Mich.
Secretary, Charles E. Brewster, Grand Rapids, Mich.

NATIONAL SPORTSMEN'S ASSOCIATION (organized June, 1893):
President, Charles Tatham, New York, N. Y.
Secretary-treasurer, J. A. H. Dressel, 320 Broadway, New York, N. Y.

NORTH AMERICAN FISH AND GAME PROTECTIVE ASSOCIATION (organized Jan. 30, 1900):
President, John W. Titcomb, St. Johnsbury, Vt.
Secretary-treasurer, L. Z. Joncas, Quebec.

## STATE ORGANIZATIONS.

ARIZONA SPORTSMEN'S ASSOCIATION: Secretary, W. L. Pinney, Phoenix.

ARKANSAS STATE SPORTSMEN'S ASSOCIATION (organized August 19, 1891):
President, E. A. Howell, Pine Bluff.
Secretary, Paul R. Litzke, Little Rock.

CALIFORNIA GAME AND FISH PROTECTIVE ASSOCIATION (organized May 26, 1900):
President, H. T. Payne, San Francisco.
Secretary, George H. T. Jackson, 147 New Montgomery street, San Francisco.

CONNECTICUT ASSOCIATION FOR THE PROTECTION OF FISH AND GAME (organized 1888):
President and treasurer, Abbot C. Collins, 18 Preston street, Hartford.
Secretary, George P. McLean, Simsbury.

DELAWARE GAME PROTECTIVE ASSOCIATION (incorporated March 28, 1879):
President, A. D. Poole, Wilmington.
Secretary and treasurer, J. Danforth Bush, Wilmington.

GAME AND FISH PROTECTIVE ASSOCIATION OF THE DISTRICT OF COLUMBIA (organized February 3, 1897):
President, Admiral Robley D. Evans, U. S. N.
Secretary, Dr. W. P. Young, 419 Tenth street NW., Washington.
Warden, Maj. Richard Sylvester, Washington.

ILLINOIS FISH AND GAME PROTECTIVE ASSOCIATION (incorporated May 1, 1897):
President, Henry W. Loveday, 1403 Schiller Building, Chicago.
Secretary, H. A. Sullivan, 1510 Ashland Block, Chicago.

ILLINOIS STATE SPORTSMEN'S ASSOCIATION (organized March 10, 1874):
President, James R. B. Van Cleave, Springfield.
Secretary-treasurer, Charles T. Stickle, Springfield.

IOWA STATE SPORTSMEN'S ASSOCIATION:
President, W. B. Kibbey, Marshalltown.
Secretary, D. R. Tripp, Newton.

KENTUCKY FIELD TRIALS CLUB (organized Aug. 23, 1899):
President, George L. Danforth, Louisville.
Secretary and treasurer, Dr. F. W. Samuel, Louisville.

KENTUCKY FISH AND GAME CLUB (incorporated June 8, 1889):
President, Frank Pragoff, 422 West Main street, Louisville.
Secretary, Hamilton Griswold, 139 Third street, Louisville.

MAINE SPORTSMEN'S FISH AND GAME ASSOCIATION (chartered 1893):
President, Hon. P. O. Vickery, Augusta.
Secretary and treasurer, Col. E. C. Farrington, Augusta.

MARYLAND STATE GAME AND FISH PROTECTIVE ASSOCIATION (organized March 5, 1895; incorporated May 13, 1898):
President, George Dobbin Penniman, Baltimore.
Secretary and treasurer, Frank C. Kirkwood, 1500 Bolton street, Baltimore.

MASSACHUSETTS CENTRAL COMMITTEE FOR THE PROTECTION OF FISH AND GAME (organized January 4, 1900):
Chairman, A. B. F. Kinney, Worcester.
Secretary-treasurer, Henry H. Kimball, 68 Devonshire street, Boston.

MASSACHUSETTS FISH AND GAME PROTECTIVE ASSOCIATION (chartered March 18, 1874):
President, James Russell Reed, 68 Devonshire street, Boston.
Secretary and treasurer, Henry H. Kimball, 68 Devonshire street, Boston.

ROD AND GUN CLUB OF MASSACHUSETTS (organized December 20, 1895):
President, John Fottler, jr., Boston.
Secretary and treasurer, W. C. Thairlwall, 95 South street, Boston.

MICHIGAN STATE GAME AND FISH PROTECTIVE LEAGUE:
President, A. L. Lakey, Kalamazoo.
Secretary, R. S. Woodliff, Jackson.

MISSOURI STATE GAME AND FISH PROTECTIVE ASSOCIATION (organized May 20, 1879):
[Formerly the Missouri State Sportsmen's Association, 1879-1888.]
President, Max C. Starkloff, St. Louis.
Secretary, Herbert Taylor, 1005 Chemical Building, St. Louis.

MONTANA FISH AND GAME PROTECTIVE ASSOCIATION (organized January, 1901):
President, Richard A. Harlow, Helena.
Secretary, A. L. Palmer, Helena.

NEBRASKA FISH AND GAME ASSOCIATION (organized April 20, 1900):
President, J. H. Ager, Lincoln.
Secretary and treasurer, F. E. Mockett, Lincoln.

NEW YORK ASSOCIATION FOR THE PROTECTION OF GAME (founded 1844; incorporated 1884):
President, Robert B. Roosevelt, 57 Fifth avenue, New York.
Secretary, Robert B. Lawrence, 35 Wall street, New York.

NEW YORK STATE FISH, GAME, AND FOREST LEAGUE (organized 1865; incorporated 1898):
President, Robert B. Lawrence, 35 Wall street, New York.
Secretary, Ernest G. Gould, Seneca Falls.

NORTH DAKOTA STATE SPORTSMEN'S ASSOCIATION (organized January 14, 1895):
President, C. A. Hale, Grand Forks.
Secretary, George Duis, Grand Forks.

[OHIO] CUVIER CLUB OF CINCINNATI (organized February 5, 1874; incorporated):
[Formerly the Ohio State Society for the Protection of Game and Fish.]
President, Alex. Starbuck, 632 West Fourth street, Cincinnati.
Secretary, William J. Lawler, 1380 Myrtle avenue, Cincinnati.

OHIO FISH AND GAME PROTECTIVE ASSOCIATION (organized April, 1900):
President, Judge O. B. Brown, Dayton.
Secretary, J. C. Porterfield, Columbus.

OHIO SPORTSMEN'S PROTECTIVE ASSOCIATION (organized June 28, 1900):
President, Ralph Worthington, Geo. Worthington Hardware Company, Cleveland.
Secretary, C. T. Bodifield, 24 South Water street, Cleveland.

OREGON FISH AND GAME ASSOCIATION (organized January 28, 1899):
President, J. N. Teal, Portland.
Secretary, A. E. Gebhardt, Portland.

PENNSYLVANIA STATE SPORTSMEN'S ASSOCIATION (organized August 22, 1890; incorporated, 1892):
President, J. O. H. Denny, Ligonier.
Secretary, J. M. Runk, Chambersburg.

[SOUTH CAROLINA] WESTERN CAROLINA GAME PROTECTION ASSOCIATION (organized January 1, 1895):
President, C. F. Dill, Greenville.
Secretary and treasurer, Charles F. Schwing, Greenville.

TEXAS GAME PROTECTIVE ASSOCIATION (organized April, 1896):
President, Hon. R. R. Lockett, Austin.
Secretary, Turner E. Hubby, Waco.

TEXAS STATE SPORTSMEN'S ASSOCIATION:
President, M. H. Thomas, Dallas.
Secretary and treasurer, V. C. Dargen, Dallas.

UTAH STATE FISH AND GAME PROTECTIVE ASSOCIATION (organized October 6, 1897):
President, T. J. Almy, Salt Lake City.
Secretary, George D. Alder, Salt Lake City.

VERMONT FISH AND GAME LEAGUE (incorporated November 21, 1890):
President, John W. Titcomb, St. Johnsbury.
Secretary, E. T. Bradley, Swanton.

EASTERN SHORE GAME PROTECTIVE ASSOCIATION OF VIRGINIA (organized 1893; incorporated March, 1894):
President, J. W. Bowdoin, Bloxom.
Secretary and treasurer, T. W. Blackstone, Accomac.

PROVINCE OF QUEBEC ASSOCIATION FOR THE PROTECTION OF FISH AND GAME (organized February 23, 1859):
President, F. L. Wanklyn, Montreal.
Secretary, William J. Cleghorn, box 1059, Montreal.

SPORTSMEN'S FISH AND GAME PROTECTIVE ASSOCIATION OF THE PROVINCE OF QUEBEC (incorporated):
Secretary, E. T. D. Chambers, Quebec.

## AUDUBON SOCIETIES.

(Organized for the study and protection of birds.)

CALIFORNIA (organized April 17, 1899):
President, Albert K. Smiley, Redlands.
Secretary, Mrs. George S. Gay, Redlands.

CONNECTICUT (organized January 28, 1898):
President, Mrs. Mabel Osgood Wright, Fairfield.
Secretary, Mrs. William Brown Glover, Fairfield.

DELAWARE (organized April, 1900):
President, A. R. Spaid, 2311 West Eighteenth street, Wilmington.
Secretary, Mrs. Florence Bayard Hilles, Delaware place, Wilmington.

DISTRICT OF COLUMBIA (organized May 18, 1897):
President, Gen. George M. Sternberg, U. S. A., Washington.
Secretary, Mrs. John Dewhurst Patten, 3033 P street, Washington.

FLORIDA (organized January, 1900):
President, Rt. Rev. H. B. Whipple, Faribault, Minn.
Secretary, Mrs. I. Vanderpool, Maitland.

ILLINOIS (organized April, 1897):
President, Ruthven Deane, 24 Michigan avenue, Chicago.
Secretary, Miss Mary Drummond, 208 West street, Wheaton.

INDIANA (organized April 26, 1898):
President, Amos W. Butler, State House, Indianapolis.
Secretary, William Watson Woollen, Commercial Club, Indianapolis.

IOWA (organized April 5, 1898):
President, Mrs. James B. Diver, Keokuk.
Secretary, Mrs. Lillian E. Felt, 524 Concert street, Keokuk.

[IOWA] SCHALLER AUDUBON SOCIETY (organized June, 1897):
President, Mrs. T. J. Andre, Schaller.
Secretary, Miss J. E. Hamand, Schaller.

KENTUCKY (organized April, 1900):
President, Mrs. Montgomery Merritt, Henderson.
Secretary and treasurer, Ingram Crockett, Henderson.

MARYLAND (organized May 24, 1899):
President, William C. A. Hammel, State Normal School, Baltimore.
Secretary, Miss Anne Weston Whitney, 615 St. Paul street, Baltimore.

MASSACHUSETTS (organized January, 1896):
President, William Brewster, Cambridge.
Secretary, Miss Harriet E. Richards, Society of Natural History, Boston.

MINNESOTA (organized June 1, 1897):
President, John W. Taylor, St. Paul.
Secretary, Miss Sarah L. Putnam, 125 Inglehart street, St. Paul.

[MINNESOTA] LAKE CITY AUDUBON SOCIETY (organized November 22, 1899):
President, Mrs. I. S. Richardson, Lake City.
Secretary, Mrs. C. A. Koch, Lake City.

NEW HAMPSHIRE (organized April 6, 1897):
President, Mrs. Arthur E. Clarke.
Secretary, Mrs. F. W. Batchelder, Manchester.

NEW JERSEY (organized May, 1897):
President, Alexander Gilbert.
Secretary, Miss Anna Haviland, 53 Sandford avenue, Plainfield.

NEW YORK (organized February 23, 1897):
President, Morris K. Jesup, New York.
Secretary, Miss Emma H. Lockwood, 243 West Seventy-fifth street, New York.

OHIO (organized December 14, 1898; incorporated):
President, William Hubbell Fisher, 13 Wiggins Block, Cincinnati.
Cor. Secretary, Mrs. D. Z. McClelland, 5265 Eastern avenue, Cincinnati.

PENNSYLVANIA (organized October, 1896):
President, Witmer Stone, Academy of Natural Sciences, Philadelphia.
Secretary, Mrs. Edward Robins, 114 South Twenty-first street, Philadelphia.

RHODE ISLAND (organized October, 1897):
President, Dr. H. C. Bumpus, American Museum of Natural History, New York.
Secretary, Mrs. H. T. Grant, jr., 187 Bowen street, Providence.

SOUTH CAROLINA (organized January 4, 1900):
President, Miss Christie H. Poppenheim, 31 Meeting street, Charleston.
Secretary, Miss S. A. Smyth, 35 Legare street, Charleston.

TENNESSEE (organized May 26, 1899):
President, P. T. Glass, Ripley.
Secretary, Mrs. C. C. Conner, Ripley.

TEXAS (organized March 4, 1899):
President, Mrs. J. W. Hertford.
Secretary, ——— ———.

WEST VIRGINIA (branch of Pennsylvania Society; organized June, 1897):
President, Witmer Stone, Academy of Natural Sciences, Philadelphia, Pa.
Secretary, Elizabeth I. Cummins, 1314 Chapline street, Wheeling.

WISCONSIN (organized April 20, 1897):
President, Edward A. Birge, Madison.
Secretary, Mrs. George W. Peckham, 646 Marshall street, Milwaukee.

## FARMERS' NATIONAL CONGRESS.

President, R. G. F. Candage, Boston, Mass.; vice-president, John S. Cuningham, Cuningham, N. C.; secretaries, John M. Stahl, No. 4328 Langley avenue, Chicago, Ill.; George A. Stockwell, Providence, R. I.; D. C. Kolp, Iowa Park, Tex., and Edward A. Callahan, Albany, N. Y.; treasurer, Levi Morrison, Greenville, Pa.; executive committee, B. F. Clayton, Indianola, Iowa; E. L. Furness, Furnessville, Ind.; W. G. Whitmore, Valley, Nebr.; T. C. Slaughter, Prosper, Tex., and E. F. Wetstein, Louisville, Ky.

## PATRONS OF HUSBANDRY.

### NATIONAL OFFICERS.

Master, Aaron Jones, South Bend, Ind.; overseer, O. Gardner, Rockland, Me.; lecturer, N. J. Bachelder, Concord, N. H.; treasurer, Mrs. E. S. McDowell, Columbus, Ohio; secretary, John Trimble, No. 514 F street NW., Washington, D. C.; executive committee, E. B. Norris, Sodus, N. Y.; J. J. Woodman, Paw Paw, Mich.; S. H. Messick, Bridgeville, Del.; Aaron Jones, ex officio, South Bend, Ind.

**OFFICERS OF**

*List of masters and other officers for*

| State. | Master. | Post-office. | Lecturer. | Post-office. |
|---|---|---|---|---|
| Alabama | H. Hawkins | Hawkinsville | Rev. A. Daugherty | Dothen |
| California | G. W. Worthen | San Jose | John S. Beecher, jr | Stockton |
| Colorado | J. A. Newcomb | Golden | J. F. White | Arvade |
| Connecticut | B. C. Patterson | Torrington | Frank S. Hopson | Station 3, Bridgeport. |
| Dakota *a* | | | | |
| Delaware | S. H. Derby | Woodside | A. T. Neale | Newark |
| Illinois | Oliver Wilson | Magnolia | D. H. Clark | Dunlap |
| Indiana | Aaron Jones | South Bend | W. W. Stevens | Salem |
| Iowa | A. B. Judson | Silver City | Geo. Van Houden | Lenox |
| Kansas, including Oklahoma. | E. W. Westgate | Manhattan | A. P. Reardon | McLouth |
| Kentucky | J. D. Clardy | Newstead | W. G. Myers | Wingo |
| Maine | Obadiah Gardner | Rockland | W. J. Thompson | South China |
| Maryland | Joseph B. Ager | Hyattsville | J. Enos Ray, sr | Chillum |
| Massachusetts | W. C. Jewett | Worcester | George S. Ladd | Sturbridge |
| Michigan | Geo. B. Horton | Fruitridge | Mrs. F. D. Saunders | Edgerton |
| Minnesota | Mrs. S. G. Baird | Edina Mills | Geo. C. Hill | Elk River |
| Mississippi | S. L. Wilson | Okolona | H. F. Simrall | Glass |
| Missouri | C. O. Raine | Benjamin | T. B. Dunham | New Cambria |
| Nebraska | J. M. Williams | Culbertson | A. M. Bovee | Vacoma |
| New Hampshire | N. J. Bachelder | Concord | Henry H. Metcalf | Concord |
| New Jersey | Geo. W. F. Gaunt | Mullica Hill | Geo. L. Gillingham | Moorestown |
| New York | Elliot B. Norris | Sodus | Mrs. S. N. Judd | Canton |
| Ohio | F. A. Derthick | Mantua | S. E. Strode | Westland |
| Oregon, including Idaho. | B. G. Leedy | Tigardville | Austin T. Buxton | Forestgrove (R. D. 64). |
| Pennsylvania | W. F. Hill | Westford | Wm. Packard | Windfall |
| Rhode Island | A. A. Smith | Woonsocket | T. S. Snow | Wakefield |
| South Carolina | W. K. Thompson | Libertyhill | C. J. Rollins | Bishopville |
| Tennessee | W. L. Richardson | Brownsville | J. M. McCorkle | Whitehaven |
| Texas | R. D. McGee | O'Daniel | J. C. Isbel | McGregor |
| Vermont | C. J. Bell | East Hardwick | R. B. Galusha | South Royalton. |
| Washington | Augustus High | Vancouver | Nicholas Ennis | Lacenter |
| West Virginia | T. C. Atkeson | Morgantown | James George | Ashton |
| Wisconsin | H. E. Huxley | Neenah | S. C. Carr | Milton Junction |

*a* Annexed to Minnesota; also Idaho is included with Oregon, Oklahoma with Kansas, and Indian Territory with Texas.

**STATE GRANGES.**

*1901, so far as reported on April 1.*

| Treasurer. | Post-office. | Secretary. | Post-office. | Date of meeting. |
|---|---|---|---|---|
| W. J. Roundtree | Valegrande | F. Schackelford, jr. | Colquitt | Wednesday after second Monday in July. |
| A. D. Logan | No. 108 Davis street, San Francisco. | Miss L. S. Woodhams. | Santa Clara | First Tuesday in October. |
| W. W. Grover | Globeville | Will. T. Wilson | Niwot | Second Tuesday in January. |
| Norman S. Platt | No. 395 Whalley avenue, New Haven. | H. E. Loomis | Glastonbury | Do. |
| ........ | ........ | ........ | ........ | ........ |
| Thomas H. Riggin | Laurel | W. W. Seeders | Farmington | Second Tuesday in December. |
| D. Q. Trotter | Piasa | Thomas Keady | Dunlap | Do. |
| J. W. Holmes | Cortland | Taylor B. Frazier | Frankfort | Do. |
| W. H. Hollister | Manchester | John Turner | Lenox | Do. |
| William Henry | Olathe | George Black | Olathe | Second Tuesday in October. |
| J. M. Clark | Hopkinsville | J. A. Browning | Church Hill | Second Tuesday in December. |
| M. B. Hunt | Center Belmont | E. H. Libby | Dirigo | Do. |
| Geo. H. Merryman | Basley | Wm. B. Sands | Lake Roland | Do. |
| F. A. Harrington | Worcester | Wm. N. Howard | South Easton | Do. |
| E. A. Strong | Vicksburg | Miss Jennie Buell | Ann Arbor | Do. |
| C. Varley | Biglake | Mrs. A. J. Adams | Box 447, Minneapolis. | Second Tuesday after December 4. |
| Mrs. Joe Bailey | Conehatta | T. J. Aby | Fayette | Second Tuesday in December. |
| W. E. Harbaugh | Liberty | E. H. Long | Monticello | Second Tuesday in October. |
| B. S. Gitchel | Butler | J. R. Catlin | Webster | Second Tuesday in December. |
| Joseph D. Roberts | Salmon Falls | E. C. Hutchinson | Milford | Third Tuesday in December. |
| C. Collins | Moorestown | M. D. Dickinson | Woodstown | First Thursday in December. |
| P. A. Welling | Hannibal | W. N. Giles | Skaneateles | First Tuesday in February. |
| W. W. Miller | Columbus | C. M. Freeman | Tippecanoe City (R. D. 64). | Second Tuesday in December. |
| J. Hershberg | Independence | Mrs. Mary S. Howard. | Mulino | Fourth Tuesday in May. |
| S. E. Niven | Landenburg | J. T. Ailman | Thompsontown. | Second Tuesday in December. |
| Benjamin Martin | East Providence | N. T. Reynolds | East Greenwich. | Do. |
| H. Baykin | Ionia | W. A. James, jr | Bishopville | First Tuesday in February. |
| D. A. Stewart | Brownsville | Mrs. E. L. Allen | Brownsville | Third Tuesday in August. |
| J. L. Howell | Dublin | J. J. Ray | Dublin | Second Tuesday in August. |
| F. B. Pier | Rawsonville | A. A. Priest | Randolph | Second Wednesday in December. |
| William Smiley | Vancouver | F. C. Briggs | Lacenter | First Tuesday in June. |
| C. T. Perry | Cuba | M. V. Brown | Buffalo | Second Wednesday in January. |
| George Harwood | Chippewa Falls. | A. C. Powers | Beloit | Second Tuesday in December. |

## OFFICIALS CHARGED WITH AGRICULTURAL INTERESTS IN SEVERAL COUNTRIES.

Argentina.—Minister of agriculture. Official address: Su excelencia el ministro de agricultura, ministerio de agricultura, Buenos Aires.

Austria-Hungary.—Minister of agriculture at Vienna and minister of agriculture at Budapest. Official addresses: K. k. Ackerbau-Minister in Wien, and K. ungarischer Ackerbau-Minister in Budapest.

Belgium.—Baron Maurice van der Brueggen, ministère de l'agriculture, Bruxelles.

Brazil.—Minister of industry, etc. Official address: Ministro da industria, viação e obras publicas, Rio de Janeiro.

Chile.—Minister of industry, etc. Official address: Ministro de industria y obras publicas, Santiago.

China.—No officer of central government. Provincial officers: His excellency the viceroy of Liang-Kiang, Nankin. His excellency the viceroy of Hu-Kuang, Wuchang. His excellency the viceroy of Liang-Kwang, Canton.

Costa Rica.—Minister of public promotion. Official address: Ministro de fomento, San Jose.

Denmark.—Official address: Landbrugsminister, 6 Slotholmsgade, Copenhagen.

France.—Minister of agriculture. Official address: Monsieur le ministre de l'agriculture, No. 78 rue de Varennes, Paris.

Germany.—Count von Posadowsky-Wehner, secretary of the interior, Berlin.

Great Britain.—The Right Hon. Walter Hume Long, M. P., president of the board of agriculture, 4 Whitehall place, London S. W.

Guatemala.—Minister of public promotion. Official address: Ministro de fomento, Guatemala City.

Haiti.—Secretary of state for agriculture. Official address: Secrétaire d'état de l'agriculture, Port au Prince.

Italy.—Director-general of agriculture, etc. Official address: Direttore generale dell' agricoltura, industria e commercio, Roma.

Japan.—Mr. Yuzo Hayashi, minister of agriculture and commerce, Tokio.

Korea.—Mr. Ye Ching Kun, Seoul, Korea, minister of agriculture.

Mexico.—Señor Leandro Fernandez, secretario de fomento, City of Mexico.

Nicaragua.—Dr. Leopoldo Ramirez Mairena, ministro de fomento, Palace of the Executive, Managua.

Russia.—His Excellency A. S. Yermolow, minister of agriculture and State domains, St. Petersburg.

Spain.—Minister of agriculture, etc. Official address: Ministro de agricultura, Madrid.

Sweden and Norway.—Count A. Wachtmeister, general direktör och chef för kongl. domänstyrelsen, Stockholm; M. M. Selmer, skogdirektör, Christiania.

Switzerland.—M. le conseiller fédéral, Dr. Adolphe Deucher, chef du département fédéral du commerce, de l'industrie et de l'agriculture, Palais Fédéral, Bern.

Turkey.—Selim Melhamé Pasha, Constantinople, minister of agriculture.

Venezuela.—Mr. Federico Fortique, dirección de agricultura y cria, Caracas.

## REQUIREMENTS FOR ADMISSION TO THE AGRICULTURAL DEPARTMENTS OF THE LAND-GRANT COLLEGES, AND THE COST OF ATTENDANCE.

The following notes on the agricultural courses in the land-grant colleges, the requirements for admission, cost of attendance, and the opportunities for self-help have been compiled from the catalogues of the several institutions. All of the institutions receiving the benefits of the acts of Congress of July 2, 1862, and August 30, 1890, offer courses in agriculture, with the exception of three, and most of them four-year courses leading to the Bachelor's degree. The larger part of the colleges also offer various short courses of secondary grade, either in general agriculture or in some special branch, as dairying. These courses are designed to give the young farmer who has not time for preparation or means to take a full course such special training as will enable him to carry on farming operations intelligently and by the most approved methods. Such courses are preeminently practical. The short courses differ greatly in length. For courses of less than one year a term of from four to twelve weeks is most common, though courses requiring two terms are advertised. In the category of one-term courses is generally found the dairy school, now so popular throughout the country.

While all the colleges teach the general principles of agriculture, they are usually taught with especial reference to their application in the prominent agricultural industries of the State; hence it is that we find a school of beet-sugar making in Nebraska, a school of sugar making in Louisiana, especial attention paid to viticulture in California, poultry raising in Rhode Island, dairying in a number of dairy States, etc. The mention of this fact may be of assistance in the selection of a college for those who wish special instruction along certain lines.

By the first Morrill Act establishing the land-grant colleges, instruction in military science is made compulsory. At all of the institutions students entering the regular course, except in some cases those especially excused on account of physical disability, are required to provide themselves with a military uniform. This must be ordered at the college immediately after entering. The cost varies from $10 to $22.30, being commonly about $15.

In a majority of the colleges there is no charge to residents of the State or Territory for tuition in the agricultural courses. In all the others there are numerous scholarships or opportunities for labor which offset this item, at least for a considerable number of students. The statements concerning the various institutions follow:

ALABAMA.—Alabama Polytechnic Institute, Auburn, W. Le Roy Broun, president. Applicants for admission to the freshman class must pass satisfactory examinations in geography, history of the United States, English, arithmetic, algebra to quadratic equations, and one book in geometry. There is a two-year short course, and some post-graduate work is offered.

There is no charge for tuition to residents of Alabama. Nonresidents of the State pay a charge of $20 for tuition. All students are required to pay incidental, library, and surgeon's fees, amounting to $12 per year. The college estimates the cost to the student of a year's residence, exclusive of uniform and books, at $127 to $171. A deposit of $35 is required of all students at entry.

The Agricultural and Mechanical College for Negroes, Normal. W. H. Council, president. Tuition is free. Board, including washing, fires, lights, and room, is $7 per month. The college provides for considerable student labor at from 4 to 15 cents per hour.

ARIZONA.—University of Arizona, Tucson. M. M. Parker, president. For admission to the freshman class applicants must pass examinations in arithmetic, algebra, plane geometry, English history and civics, elementary science, and either Latin, German, French, manual training, or advanced science. Tuition is free. The college estimates the cost of a year's residence at from $150 to $200, exclusive of clothing. Provision has been made for the self-support of students to a limited extent.

ARKANSAS.—Arkansas Industrial University, Fayetteville. J. L. Buchanan, president. There are two courses in agriculture—a full course leading to the degree of B. S., and a special course leading to the degree of B. A. S. The requirements for admission comprise English, arithmetic, algebra to simultaneous quadratic equations, plane geometry (four books), United States and general history, geography, and physiology.

Tuition is free to residents of Arkansas, and $30 per year to nonresidents. The necessary expenses of a student who wishes to live economically are placed by the college at $109 for the first year, which includes the cost of uniform, and $94 a year thereafter. The State has made provision for the maintenance of 1,000 beneficiary students, to whom the charge for tuition is remitted. Beneficiary students are distributed to the counties of the State in proportion to population, and appointments are made by county judges. A State appropriation of $2,500 as a "Students labor fund" has usually been made. Students are paid for work out of this fund. Thus many of them pay, in part, their expenses.

CALIFORNIA.—University of California, Berkeley. B. I. Wheeler, president. The requirements for entrance comprise English, algebra, plane geometry, government of the United States, physics, chemistry, advanced mathematics or botany or zoology, and Latin or Greek, or further requirements in English or French or German. An equivalent in entomology is accepted in lieu of zoology.

Tuition is free. There are laboratory fees, and a charge for military uniform. The university maintains no dormitories. Board and lodging may be obtained in private families at from $18 to $30 per month. The hours of recitation are such that many students reside in Oakland and San Francisco, the journey from the latter point requiring from an hour to an hour and a quarter. The cost of board and lodging in clubs ranges from $15 to $35 a month. A few students board themselves as low as $10 a month, but this plan of living is not generally recommended. The institution has a considerable number of scholarships at its disposal.

COLORADO.—The State Agricultural College of Colorado, Fort Collins. B. O. Aylesworth, president. Students are admitted to the college according to the following statute: "No student shall be admitted to the institution who is not 15 years of age, and who does not pass a satisfactory examination in arithmetic, geography, grammar, reading, spelling, and penmanship." These requirements are practically covered by the eighth grade of the school system of the State, and such students are eligible for admission to the subfreshman class. For entrance to the freshman class the requirements are equivalent to those of the work of the tenth grade of the public schools or of the second-year grade of the best high schools of the State.

Tuition is free. Furnished rooms may be had at 75 cents a week, and board has been obtained in student clubs at $2.25 per week. Board in private families costs from $3.25 to $4 per week. The college is an employer of student labor to a limited extent.

CONNECTICUT.—The Connecticut Agricultural College, Storrs, Conn. George W. Flint, president. Applicants for admission must be residents of Connecticut and must pass satisfactory examinations in arithmetic, geography, history, English, and reading.

Tuition and room rent are free. Each room contains a bed, mattress, study table, and chairs. The college furnishes fuel, lights, books, and stationery as nearly as possible at cost prices. Board is furnished at the boys' hall at $2.75 a week. Expenses of individual students will vary from $125 a year to $200. An advance payment of $40 a term is required of every student rooming in the college buildings. The college gives employment to worthy and industrious students who have to pay their own way. The short dairy course is given during the winter term of twelve weeks.

DELAWARE.—Delaware College, Newark. G. A. Harter, president. Besides the regular four-year course in agriculture the college offers the two-year course and a winter course of three months. Candidates for admission to the regular course must pass thorough examinations in English, history of the United States, American literature, geography, arithmetic, algebra through quadratic equations, and plane geometry.

Tuition is free to all students from Delaware. Others pay $60 per year. There are incidental charges amounting to $11 a year besides the entrance fee of $5. Heated rooms may be obtained in the college dormitories for $22 per year. Table board may be obtained at less than $3 per week.

State College for Colored Students, Dover. W. C. Jason, president. Applicants for admission must be able to pass a satisfactory examination in reading, writing, spelling, arithmetic, English grammar, and history of the United States. Tuition is free to all Delaware students. Those from other States, unless admitted by special arrangement, will be charged $8 for the first term and $6 each for the second and third terms. Board is furnished by the college at a cost not exceeding $2 per week, and rooms with the necessary furniture are free. The total necessary expense is about $8 per month.

FLORIDA.—Florida Agricultural College, Lake City. W. F. Yocum, president. Candidates for admission must be prepared in the subjects taught in the preparatory course in the college. These comprise, in part, arithmetic, algebra, geometry, drawing, United States history, physical geography, grammar, natural philosophy, English, elementary botany, and civil government.

Tuition is free to all residents of the State. Others pay $20 a year. An incidental fee of $2 per term is required of all students, and those rooming in the barracks pay in addition $3 per term for room and light. Board may be obtained at the barracks for $10 per month.

Agricultural students are employed on the farm and in the garden to a limited extent, and are able thus in connection with their studies to earn from $6 to $10 per month. In addition to this the trustees offer free scholarships covering board, tuition, and all fees, to be competed for by the students of the freshman, sophomore, and junior classes. This competition is open to agricultural students as well as others.

Florida State Normal and Industrial College, Tallahassee. T. De S. Tucker, president. This college is for colored students. There is no charge for tuition. An approximate estimate of the necessary expenses for a full session is placed at $73.75. A limited number of young men will, upon payment of $36 in cash at the beginning of the session, be allowed to work out the balance of their board and laundry expenses. All extra work performed by students is rated at 5 cents per hour.

GEORGIA.—Georgia State College of Agriculture and Mechanic Arts, Athens. H. C. White, president. The regular course in agriculture in this institution requires four years for completion. There is also a short winter course of three months. Graduate courses in agriculture and horticulture are offered. For admission to the regular course the candidate must be prepared in arithmetic, algebra, two books of geometry, spelling, and composition. The entire expense for the short course, exclusive of traveling expenses, need not exceed $50.

Georgia State Industrial College for Colored Youths, College. R. R. Wright, president. Applicants for admission must show ability to read and write the English language correctly and to prepare an original composition, and must be sufficiently advanced in mathematics to begin the study of algebra and geometry. Provision has been made for the admission of students of a preparatory grade.

Tuition is free to all citizens of the State. Board and washing are furnished by the college at about $5 per month. Books are sold at cost, and medical attendance is provided at a very moderate rate. All students are required to do some manual work, and that which is not distinctly instructive or a part of the regular course is paid for at 5 cents per hour.

IDAHO.—College of Agriculture of the University of Idaho, Moscow. James A. McLean, president. Candidates for admission must pass examinations in algebra, plane and solid geometry, English, physical geography, physiology, physics, botany, general history, and a year of French or German. Equivalent work in zoology or chemistry would be accepted as a substitute for the year's work in physics or botany. For students who are not prepared to meet these requirements there is a preparatory department. Besides the regular four-year course in agriculture, there is a short two-year course, for which the requirements of entrance are the same as for those in the preparatory department, and a short winter course of three or four weeks, for which no special preparation is required.

Tuition is free to all residents of the State. Nonresidents pay $15 per year in the university and $9 in the preparatory department. Table board is furnished at $2.25 per week, and unfurnished rooms are rented at $1 a month.

ILLINOIS.—College of Agriculture of the University of Illinois, Urbana. A. S. Draper, president. The requirements for admission comprise algebra, English composition, English literature, plane geometry, history, and the equivalent of one year of physical or biological science in the high school, together with several selections from a considerable list of electives.

Tuition is free except to conditioned and special students, who pay $7.50 each semester. All students, except those in the graduate school and those holding scholarships, pay an incidental fee of $24 a year. The estimated average expense of a year's residence at the university is placed at from $159 to $233.

There is a system of State scholarships which provides for the support of one person from each county of the State at the university for a term of four years free of charge for tuition or any incidental charge, with certain minor restrictions; also another system of two-year scholarships in the College of Agriculture only. In this college those not desiring to matriculate may be admitted as special students if above the age of 16.

INDIANA.—School of Agriculture, Horticulture, and Veterinary Science of Purdue University, Lafayette. W. E. Stone, president. In addition to the regular course, the university offers a special two-year course and a short winter course of eleven weeks. Applicants for admission to the full course must pass satisfactory examinations in English, including grammar, the elements of composition, reading and spelling, descriptive geography, United States history, arithmetic, algebra through quadratics, and in plane geometry after 1902.

Tuition is free to all residents of the State. Table board may be obtained variously at $2.50 and $2.75 a week. Room rent, with heat and light, is estimated at $1 a week. The State has made provision for the appointment of two students from each county to the university, the students thus appointed being exempt from the payment of entrance and incidental fees, and being permitted to have rooms in the dormitory without charge, provided there are vacancies. This reduction amounts to about $40 a year, and under such conditions the necessary expenses of the student are about $150 per annum. County agricultural societies are also permitted to grant scholarships in agriculture exempting the holders from all fees. The university offers a very limited amount of employment to students.

IOWA.—Iowa State College of Agriculture and the Mechanic Arts, Ames. W. M. Beardshear, president. Besides the regular four-year course in agriculture, this institution offers a one-year course in dairying, two summer schools in dairying, one beginning with the regular college year in August and continuing sixteen weeks, and the other beginning with the second regular college term in February, and continuing the same length of time. Further, there is a winter school in dairying which begins January 25 and continues four weeks.

The requirements for admission to the four-year course comprise geography, arithmetic, United States history, human physiology, algebra to simple equations, orthography, reading, and grammar.

Tuition is free to residents of the State; others pay $30 per year. Table board may be obtained at the college at $2.25 per week. Room rent may be obtained at $3 per term, and the expense for lighting, heating, and incidentals is from 70 to 85 cents per week. Text-books and stationery are furnished to students at actual cost to the college. The college offers a limited amount of compensated labor to sudents.

KANSAS.—Kansas State Agricultural College, Manhattan. E. R. Nichols, president. Besides the regular four-year course, this institution offers a dairy-school course of one winter term, and a farmers' short course in agriculture, horticulture, and mechanics. Applicants for admission to the regular course must be satisfactorily prepared in reading, spelling, writing, geography, arithmetic, United States history, English grammar, English composition, elementary physiology, bookkeeping, and algebra through simple equations of one unknown quantity.

Tuition is free, and there is no charge for incidental or contingent expenses. Table board may be obtained in student clubs at from $1.50 to $2.25 per week. Furnished rooms, without board, may be obtained at from $3.50 to $5 per month. The ordinary expenses of residence, aside from clothing and traveling expenses, are stated to range from $100 to $200 a year. Students in straitened circumstances financially are encouraged and aided in every way possible, the college itself being a considerable employer of student labor.

KENTUCKY.—Agricultural and Mechanical College of Kentucky, Lexington. J. K. Patterson, president. Candidates for admission are examined in advanced English grammar, composition, rhetoric, and synonyms; descriptive, political, and physical geography; United States and general history; arithmetic; algebra through quadratic equations, and two books of plane geometry.

Tuition is $15 a year. Each State representative district is allowed to send, on competitive examination, one properly prepared student each year to the college free of charge for tuition. To such students, occupying a room in the dormitory and boarding in the common mess, no charge is made for room rent or matriculation, and the necessary expenses of a year's residence are about $124.50. By the terms of recent legislation, a county appointee is further entitled to have his traveling expenses from his home to the college and return paid by the college under certain conditions. The college offers a limited amount of paid employment to students. The institution offers a one-year short course in agriculture.

State Normal School for Colored Students, Frankfort. J. S. Hathaway, president. Candidates for admission are required to complete the common-school branches. Tuition is free to all colored residents of Kentucky who fulfill the required conditions. Colored nonresidents of the State are charged $2 per month. Board, including table board, room, fuel, etc., may be obtained in the school dormitory for $7.50 per month. Rooms without board may be obtained at from $3, unfurnished, to $4.50, furnished, per month.

LOUISIANA.—Louisiana State University and Agricultural and Mechanical College, Baton Rouge. T. D. Boyd, president. Applicants for admission must be prepared in the subjects taught in the subfreshman department of the college which comprise: Advanced arithmetic; algebra through quadratics; English grammar, composition, and literature; United States history and civil government; physiology and hygiene; physical geography; declamation, and penmanship. Connected with the university is the Audubon Sugar School, the aim of which is the preparation of sugar experts. The growing of beets and sorghum, as well as sugar cane, are taught. The regular course is four years, but students may take a shorter course by electing only such subjects as they desire.

Tuition in both institutions is free. All cadets, except the older students of the sugar school and such others over 21 years of age as may receive permission to board in the town, are required to board and lodge at the university and are provided with comfortable rooms without cost. Table board may be obtained at a boarding house which is under the supervision of the institution for $12 per month. The total expenses for maintenance for a scholastic year are $120, exclusive of cost of text-books and military uniform.

Southern University and Agricultural and Mechanical College, New Orleans. H. A. Hill, president. This institution is for the colored residents of Louisiana. All students in the seventh grade, and above, of the university are entitled to enter the agricultural department. Besides the regular course, the institution also offers two-year short courses in agriculture and in dairying.

Tuition is free and board is charged at the rate of $8 per month, most of which may be paid in labor by the student during working hours.

MAINE.—The University of Maine, Orono. A. W. Harris, president. Besides the regular four-year course in agriculture, this institution offers special short courses of one and two years, a special course in horticulture, and a six-weeks' course in dairying. Candidates for the regular course are examined in English; one year of a foreign language, either ancient or modern; algebra; plane geometry; and any two of the following: Botany, chemistry, physical geography, physics. Candidates for short courses in agriculture are examined in arithmetic, English grammar, physiology, English, United States history, algebra through simple equations of the first degree, and any one of the following: Botany, chemistry, physical geography, or physics.

There are no examinations for the short winter courses. Applicants for admission to the regular course must file with the treasurer a bond for $150, signed by two bondsmen, as security for the payment of term bills.

Tuition is $30 per year, except for those in the short courses, to whom no tuition charge is made. Loans, covering nearly all university charges, are available for worthy students in need of help. The necessary annual expense of residence is about $200. There are certain opportunities for self-help.

MARYLAND.—Maryland Agricultural College, College Park. R. W. Silvester, president. Applicants for admission must be prepared in English grammar, composition, and analysis, United States history, arithmetic, algebra to quadratics, and political and physical geography. For those who can not meet these requirements there is a preparatory department, the requirements for which are English grammar, arithmetic to percentage, United States history, and political geography.

The expenses of the college year for regular boarding students amount to $165. Day students pay $35. The college has at its disposal a number of free scholarships—three for Baltimore city, and one for each county of the State. These are awarded on the basis of competitive examinations and are worth $80 each.

MASSACHUSETTS.—Massachusetts Agricultural College, Amherst. H. H. Goodell, president. Besides the regular four-year course, this institution offers short courses of eleven weeks in agriculture, chemistry, botany, entomology, horticulture, and dairying. Candidates for admission to the regular course are examined in English grammar, geography, United States history, physiology, physical geography, arithmetic, including the metric system, algebra through quadratics, two books of geometry, and civil government.

Tuition is $80 a year for foreigners, but free to all citizens of the United States. The total necessary expenses of residence are estimated at from $151.15 to $291.55 a year, exclusive of laboratory fees and expenses for lights and text-books. The college offers a limited amount of employment to worthy students. Those desiring to avail themselves of this opportunity must bring a certificate signed by one of the selectmen of the town in which they are resident, certifying to the fact that they require aid.

There are a considerable number of free scholarships, one from each Congressional district in the State, for which application should be made to the Representative of the district to which the applicant belongs, and eighty State scholarships of $80 each, for which application should be made to the State senator of the district in which the candidate lives. This institution offers a number of post-graduate courses for the master's degree, and regular courses in chemistry, botany, and entomology for the degree of Ph. D.

MICHIGAN.—Michigan Agricultural College, Agricultural College. J. L. Snyder, president. Candidates for admission must be not less than 15 years of age, and must pass examinations in arithmetic, geography, grammar, reading, spelling, penmanship, and history of the United States. The institution offers special six-weeks' courses in dairy husbandry, creamery management, live-stock husbandry, and fruit culture, a four-weeks' course in cheese making, and a course in beet-sugar making beginning in January and continuing through the school year.

No charge is made for tuition except to nonresidents of the State, who pay a fee of $5 per term. The college estimates the probable annual cost of residence for the average student at $126.27. This amount may be reduced by wages received for voluntary labor. Certain advance payments, varying from $57.50 to $91.75, are required of each student on arrival.

MINNESOTA.—College of Agriculture of the University of Minnesota, St. Anthony Park, St. Paul. C. Northrop, president. The courses in agriculture comprise the regular four-year college course, a separately organized three-years' "School of Agriculture" of secondary grade, and a four weeks' dairy school. For admission to the school of agriculture applicants must have completed a common school course in English grammar, arithmetic, history of the United States, and geography. For such as can not meet these requirements there is a preparatory class, for which the requirements for admission are reading, letter writing, and arithmetic through fractions, or a third-grade certificate from the county superintendent. For admission to the college course candidates are required to show attainment equal to that represented by the certificate of graduation from the school of agriculture. Graduates from high schools may be admitted to the freshman class after spending a year in the school of agriculture, pursuing such studies as the faculty may require. Before graduation, however, all of the required work in the school of agriculture must be completed. For admission to the dairy school no entrance examination is required. Candidates must have had at least one season's experience in a creamery or cheese factory before coming to the school.

The actual total expenses of a year's residence for a number of students which were considered as fairly representative of the student body are stated at from

$217.50 to $397.09. The neighborhood of the university affords the student excellent opportunities for self-help, and those "who want to work seldom fail to find it." In the school of agriculture board is furnished students at cost, which does not exceed $3 per week. A month's board is assessed in advance. Text-books are furnished at an annual rental of $2 to students who do not desire to purchase. Drawing tools may be had at a rental of 25 cents per term, or may be purchased for about $3. A deposit of $5 is required of each student at the beginning of the term as a guaranty for the return of all books, tools, and other articles borrowed. The total expenses of a year's residence need not exceed $85 to each student. In the dairy school a registration fee of $15 is required of each student. Board may be secured near the school for from $3.50 to $4 per week.

MISSISSIPPI.—Mississippi Agricultural and Mechanical College, Agricultural College. J. C. Hardy, president. Candidates for the freshman class must be prepared in English grammar, arithmetic, geography, and United States history. For those who can not meet these requirements there is a preparatory department. Besides the regular four-year course, there are short courses of two years and of ten weeks.

Tuition is free for the undergraduate course, after which $20 a year is charged. Unfurnished rooms are free and coal is charged at actual cost. Board is also furnished at cost, the average expense being about $7.35 a month. All students in the agricultural course are required to do a certain amount of manual work, for which they are paid at the rate of 8 cents per hour. In this way students can ordinarily earn about $25 a year, though some have earned as much as $50.

Alcorn Agricultural and Mechanical College, Westside. W. H. Lanier, president. This is the Mississippi State college for the colored race. This institution offers a five-year industrial course, in which is included instruction in agriculture. Candidates for admission must be prepared to take up work in the fourth reader, elementary arithmetic, manual of geography, and advanced spelling book. Those who complete this industrial course, or its equivalent, are admitted to the regular four-year college course.

Tuition is free to all residents of the State. To others a charge of $5 per term is made. The charge for board and washing is $5 per month, and there are other fixed dues amounting to $8 per year. Many students pay about one-fourth of their expenses by working at the college, and some pay more.

MISSOURI.—College of Agriculture and Mechanic Arts of the University of Missouri, Columbia. R. H. Jesse, president. Besides the regular college course, this institution offers a two-year short course in agriculture and twelve-week courses in agriculture and horticulture. The requirements for admission comprise two years each of mathematics and English in the high school, and one year each of any two of the following: English, mathematics, history, chemistry, physics, botany, zoology, French, German, or Latin. Students, except State cadets, pay an entrance fee of $5 per year. The actual cost of a year's residence at the university is estimated at from $110 to $255, a conservative estimate being $172. Many students of the university pay more or less of their expenses by their own exertions. A number pay all their expenses in this way. The university has at its disposal a number of scholarships and fellowships. One of these, amounting to $50 a year, is devoted exclusively to the College of Agriculture and Mechanic Arts. Furthermore, each senator and representative of the general assembly of the State may appoint a cadet, and sometimes two cadets, from his district. Such cadets form a distinct military organization and form an integral part of the National Guard of Missouri. They are excused from the payment of tuition and other fees. The State legislature makes a reasonable appropriation for students' labor to assist students who are compelled to pay their way by their own exertions.

Lincoln Institute (for Colored Persons), Jefferson City. J. H. Jackson, president. Tuition in the college and college preparatory departments is $1 per term. Board is $7 per month to those who assist in doing the necessary work in the boarding department. Those who do not work are charged $8.50 per month.

MONTANA.—The Montana College of Agriculture and Mechanic Arts, Bozeman. J. Reid, president. This institution offers a regular four-year course and a shorter one consisting of two years of one term each. Candidates for admission to the freshman class must be graduates of the preparatory department or of an accredited high school, or present an equivalent.

The tuition fee is $10 per year, except in the short course in agriculture, where it is $5. There are no dormitories in connection with the college. Board and room may be had in private families for $15 a month and upward. The expense may be lessened by joining in a students' club.

NEBRASKA.—The Industrial College of the University of Nebraska, Lincoln. E. B. Andrews, president. This institution offers instruction in agriculture in a regular four-year college course, in a school of agriculture which is a secondary technical school, and in an eleven weeks' winter course. A separate department of the university of interest in this connection is the sugar school, the objects of which are to give instruction in sugar-beet culture and factory methods of sugar making. Especial attention is given to the chemical control of sugar-factory operations.

Applicants for registration must pay the usual matriculation fee of $5 and make a deposit to cover breakage and other laboratory expenses, the latter of which will not exceed $6 for the entire course.

For admission to the first year of the regular college course applicants must be prepared in algebra, including logarithms, plane and solid geometry, and plane trigonometry, elementary agriculture and horticulture, drawing and shopwork, English, elementary botany, elementary physics, elementary entomology, language, and history.

For admission to the school of agriculture candidates must be at least 16 years of age and be prepared in arithmetic, grammar, geography, United States history, physiology, reading, spelling, and writing. Plans for accrediting rural and village schools to the school of agriculture have been completed. By this system students from rural schools may enter this technical school of the university without examination. The course in this school covers three years, and may be taken by women. Tuition in the school of agriculture is free.

There are other college charges amounting to about $17. Table board may be obtained in students' clubs as low as $2 per week, and in private families for $2.25 to $2.50 per week. Room rent varies from $2 to $3 and upward per month. The average cost of a year's attendance at the university in the regular courses is about $200, though many students spend much less than this. The university guarantees no employment to any students, but there are many opportunities for work in the neighborhood. It is advised that no student enter the university unless he has at least $100. The university has a number of scholarships at its disposal.

NEVADA.—School of Agriculture of the Nevada State University, Reno. J. E. Stubbs, president. Candidates for admission must be prepared in English, algebra, plane and solid geometry, arithmetic, United States and English history, physical geography, elementary physics and elementary chemistry.

The university furnishes rooms to young men in Lincoln Hall without charge. Table board may be obtained at the university at $15 per month.

NEW HAMPSHIRE.—The New Hampshire College of Agriculture and the Mechanic Arts, Durham. C. S. Murkland, president. Besides the regular four-year course, this institution offers a two-year course, a ten weeks' winter course, and a ten weeks' dairy course. Candidates for admission to the freshman class must be prepared in arithmetic, including the metric system; algebra through quadratic equations, plane geometry, physics, botany, physical geography; history of the United States, of Greece, and of Rome; French, and English. There is a preparatory class, to which the requirements for admission are algebra to quadratics but not including radicals, English grammar and composition, physical geography, and history of the United States. Candidates for admission to the two-year course in agriculture are examined in arithmetic, English grammar (including spelling and writing), and geography and history of the United States.

Tuition is $60 per year. There are thirty scholarships, each paying $100, which are assigned exclusively to young men taking an agricultural course. There is one scholarship which pays tuition for each of the twenty-four senatorial districts. There are also certain other scholarships. Students receiving these pay their own tuition. The college furnishes pecuniary assistance to students in the way of work to a considerable extent. The necessary expenses of residence per year are estimated at from $148 to $257.50.

NEW JERSEY.—Rutgers Scientific School (the New Jersey State College for the Benefit of Agriculture and the Mechanic Arts), New Brunswick. Austin Scott, president. The requirements for admission comprise arithmetic, algebra through progressions, plane and solid geometry, English, United States history, physics, and chemistry.

Tuition is $75 a year. Among the fixed annual expenses are an admission fee of $5, graduation fee of $7, and a charge for public room service of $24. There is an additional laboratory fee of $15 per annum for students pursuing the course in agriculture, the course in engineering, the course in electricity, and the course in biology, and of $30 for those pursuing the course in chemistry. A system of State scholarships provides for the payment of tuition at the college of one or more students from each county. Appointments are made on the recommendation of the superintendent of schools in each county, after passing the required examinations. The trustees of the college have also provided ten additional State scholarships. There is another system by which one scholarship is awarded to each assembly district. The candidates are selected by competitive examination.

NEW MEXICO.—The New Mexico College of Agriculture and Mechanic Arts, Mesilla Park. F. W. Sanders, president. Candidates for admission must be prepared in English, general history, algebra through logarithms, physics, elementary chemistry, physical geography, Latin, physiology, civil government, free-hand drawing, arithmetic, history of the United States, geography, and carpentry and wood-working tools, or an equivalent in natural science, language or history. The institution maintains a preparatory department.

Tuition is free to citizens of the United States. Others pay $50 per year. Text-books are furnished by the college, and are either sold at cost or lent. Students are required to deposit $2.50 in advance to secure the proper care of college property and the prompt return of books borrowed. The total annual expense of residence for college incidentals, board and lodging, and washing is estimated at from $127 to to $181. The college offers students a considerable opportunity for self-help.

NEW YORK.—Cornell University, Ithaca. J. G. Schurman, president. The courses in agriculture in this institution are numerous and highly specialized. The requirements for admission are English; American, English, Grecian, or Roman history (any two); plane geometry, elementary algebra, and any one of the three following groups: Greek and Latin; Latin and either advanced French or advanced German; advanced French, advanced German, and advanced mathematics. Equivalents may be offered for the advanced mathematics, provided, however, that the student before graduation must have passed in one modern language and in advanced mathematics, if these subjects were not offered for entrance. There is a special short course, and the university has besides, as separate departments, a college of forestry and a veterinary college. Tuition is free, but there is an incidental fee of $7.50 per half year. A fellowship for post-graduate work of an annual value of $500 is assigned to a group composed of the departments of agriculture, horticulture, and veterinary science.

NORTH CAROLINA.—The North Carolina College of Agriculture and Mechanic Arts, West Raleigh. George T. Winston, president. Candidates for admission to the full courses must be prepared in arithmetic complete, algebra through simple equations, English grammar, analysis and composition, and United States history. Besides the regular course there is a two-year course and a three-months' course.

Tuition is $20 per year, except to post graduates, to whom it is free. Lodging, fuel, and lights are $22.50 per year. One hundred and twenty scholarships, covering tuition and lodging, are distributed among the counties according to their representation in the lower house of the State legislature. The total expense to such students is about $100 per annum, to others $130. The college offers a limited amount of work to its students, but first-year students can not hope to realize over $2 to $3 a month from this source.

The Agricultural and Mechanical College for the Colored Race, Greensboro. J. B. Dudley, president. Candidates for admission must understand fairly well the forms and rules of the English language, must be familiar with arithmetic, and have a knowledge of geography and history. For applicants who can not meet these requirements there is a preparatory department.

Tuition is $1 per month of four weeks. A limited number of students from each county are allowed free tuition. Any person who wishes to avail himself of this offer must procure from the examiner of his county a certificate setting forth that he has passed an examination equivalent to that required of every second-grade teacher. The necessary expenses of students in residence, including board, are about $7 per month, which must be paid in advance.

NORTH DAKOTA.—North Dakota Agricultural College, Agricultural College. J. H. Worst, president. This institution offers, besides the regular four-year course, a two-year short course, and a farm school of three months. Candidates for admission to the regular course must be prepared in English grammar, writing, and spelling, United States history, geography, arithmetic, general history, and civil government of the United States.

Tuition is free to residents of the State. Board with room may be obtained at the college by a limited number of students at $3.50 per week, payable four weeks in advance. Rooms with private families may be obtained at from $6 to $10 a month, and board at from $2.50 to $4 a week.

OHIO.—The Colleges of Agriculture and Domestic Science and of Veterinary Medicine, Ohio State University, Columbus. W. O. Thompson, president. The College of Agriculture and Domestic Science offers three four-year courses: Agriculture, horticulture and forestry, and domestic science; a two-year course in agriculture; a two-year course in domestic science, and a three-months' course in dairying. Candidates for admission to four-year courses must be prepared in arithmetic, descriptive and physical geography, English grammar, United States history, English, algebra, botany, plane geometry, physics, either civil government or general history, and any one of the following: Latin, French, or German. The university includes a college of veterinary medicine.

The expense of a year's residence, including cost of uniform, is estimated at from $143.50 to $348. The institution offers in the College of Agriculture and Domestic Science a free scholarship, good for the two-year courses or the first year of either of the short courses and the first year of either of the four-year courses, to one student from each county in Ohio. The scholarship covers incidental and all laboratory fees. There is a large amount of work on the university farm which is assigned to students, preference being given to those who are studying agriculture. The university does not, however, promise work to all applicants. There are many opportunities for students to work in the city. "It has seldom been known that any student of ordinary energy and industry was obliged to leave the university because of a lack of money for necessary expenses after having been, say, sixty days on the ground. An employment bureau is maintained at the university."

Oklahoma.—Oklahoma Agricultural and Mechanical College, Stillwater. A. C. Scott, president. Besides the regular course, this institution offers a special eight-weeks' winter term in agriculture and the mechanic arts. Candidates for admission must be at least 14 years of age, and must be prepared in reading, spelling, penmanship, geography, United States history, grammar, and arithmetic. For those who are not able to meet these requirements there is a preparatory department.

Tuition is free. Table board may be obtained in students' clubs at from $1.75 to $2 per week. The college gives considerable work to students.

Agricultural and Normal University, Langston. Inman E. Page, president. This is the Oklahoma college for colored persons. The institution was established in 1897, but courses in agriculture were organized only in the fall of 1900.

Oregon.—Oregon State Agricultural College, Corvallis. T. M. Gatch, president. Besides the regular course, this institution offers a short winter course of one term. For admission to the regular course, applicants must be able to pass a satisfactory examination in reading, spelling, geography; arithmetic, including the metric system; United States history, English grammar and composition, and algebra to quadratic equations.

Tuition is free, and no incidental fees are collected except laboratory fees.

Pennsylvania.—The Pennsylvania State College, State College. G. W. Atherton, president. Besides the regular course, this institution offers a short course in agriculture of twelve weeks, and courses in dairying and in creamery work of six weeks. Candidates for admission to the regular course must be prepared in arithmetic, including the metric system; English classics, United States history, algebra through quadratics and progressions, plane geometry, and physics. For those who can not meet these requirements there is a preparatory class of one year. Candidates for admission to the preparatory department must be at least 15 years of age, and be prepared in arithmetic, English grammar, United States history, algebra through simultaneous equations, and physical geography.

No charge is at present made for tuition to residents of Pennsylvania. To students from other States the charge is $100 a year. The college does not maintain a boarding hall. Table board may be obtained in the vicinity for $3 a week, or in students' boarding clubs at from $2.50 to $3 a week.

The institution offers fifty scholarships, one for each senatorial district in the State, entitling the holder to exemption from all college charges except for lights and material used in the laboratories in the regular course. Appointments are made by the senator of the district after a competitive examination.

Rhode Island.—Rhode Island College of Agriculture and Mechanic Arts, Kingston. J. H. Washburn, president. Besides the regular course, this institution offers a winter course in agriculture, mechanics, and horticulture, with shop and laboratory work, together with a poultry school extending through six weeks. The institution also maintains a preparatory department. Candidates for admission to the regular course must be prepared in arithmetic, algebra, plane geometry, English grammar, advanced English, United States history, physical and political geography, and one year of German, French, or Latin.

Tuition is free to all Rhode Island students. The regular expenses for a year's residence vary from $150 to $200. The college offers a limited amount of work to students who maintain a satisfactory standing in their classes.

South Carolina.—Clemson Agricultural College, Clemson College. H. S. Hartzog, president. Candidates for admission must be prepared in arithmetic, elementary algebra, English grammar, geography, and history of the United States. A preparatory course is provided for students not sufficiently advanced for the college classes.

Tuition is $40 per year, but is remitted to those parents or guardians who present a certificate indorsed by the county auditor that they are unable to make the payment. The expenses of a year's residence, including matriculation and medical fees, cost of military uniform, and board and washing, amount to $99.80. The institution offers students a limited opportunity to defray a part of their expenses by work.

The Colored Normal, Industrial, Agricultural, and Mechanical College, Orangeburg. T. E. Miller, president. Candidates for admission to the college department are examined in the studies of the college preparatory department or their equivalents, viz: English grammar, history, composition, geography, high-school arithmetic, algebra through quadratics, and elementary physics, chemistry, and physiology. Every student over 12 years of age must do two hours' manual labor per week, under the direction of the president of the college. In assigning work due regard is had to the course of study pursued by the student.

There is no charge for tuition, unless the parents or guardians have an income of $1,000 per year. Board in the dormitories, including furnished rooms and washing, costs about $35 for the school term. For room rent alone in the dormitories no charge is made. Text-books may be bought at the college at cost, which is almost exactly $8 a year throughout the course.

South Dakota.—South Dakota Agricultural College, Brookings. J. W. Heston, president. The regular course in this college requires five years for completion. The institution offers short courses in agriculture, horticulture, and dairying, requiring one term each. Candidates for admission must have completed the work of the public schools as far as the ninth grade.

Tuition is $6 a year. The aggregate of all regular fees, exclusive of laboratory fees, is $4 per quarter. It is stated that any fairly prudent student can pay all his expenses with $165 in a year. There is a limited amount of paid labor about the institution which is offered to deserving students.

Tennessee.—State Agricultural and Mechanical College of the University of Tennessee, Knoxville. C. W. Dabney, president. Candidates for admission must be prepared in English, arithmetic, algebra through quadratics, and any one of the following: History, physics, physiology, botany, Latin, Greek, French, or German.

Registration and tuition are free. There is an incidental fee of $10. The actual necessary expenses of a year's residence vary from $150 to $230. The university offers a limited amount of paid labor to students, but no work is promised anyone until he has been at the university at least one term and had opportunity to show what he can do. Post-graduate courses in agriculture will be provided on application.

There is a ten weeks' course, for which no entrance examination is required. Tuition is free, the only charge being the contingent fee for the term, which is $7. All expenses of attending the course, including board and lodging, for the ten weeks need not exceed $50.

Texas.—State Agricultural and Mechanical College of Texas, College Station, L. L. Foster, president. Applicants for admission to the lowest (fourth) class must be prepared in arithmetic, elementary English grammar and composition, history of Texas, and geography. Applicants for admission to the third class, with which the regular agricultural course begins, must be prepared in arithmetic, algebra to quadratic equations, English grammar, United States history, and physical geography. There is also a six weeks' summer course.

The necessary expenses for a year's session are $140, exclusive of military uniform and books. The State legislature has provided a fund by which a limited number of industrious young men may defray a part of their expenses while at college. Every student, however, should bring with him money enough to defray his expenses for the first three months.

Prairie View State Normal and Industrial College, Prairie View. E. L. Blackshear, principal. This is the Texas State institution for the colored race. Candidates for admission must sustain a satisfactory examination in arithmetic as far as percentage, orthography, English grammar and composition, geography, and history of Texas and of the United States. Students are of two classes—State students and pay students. The total cost of maintaining a pay student for one year, not including clothing, is $100. State students are appointed, one by each of the 150 State legislators. Such students pay the entrance fee of $10, and $30 per year toward their maintenance.

Utah.—The Agricultural College of Utah, Logan. W. J. Kerr, president. Graduates of the eighth grade of the district schools are admitted to the subfreshman class without examination. For admission to the freshman class candidates must pass satisfactory examinations in reading, spelling, penmanship, geography, United States history, grammar, and arithmetic. There is a short course of two years. Tuition is free.

Vermont.—University of Vermont and State Agricultural College, Burlington.

M. H. Buckham, president. Residents of Vermont are not required to pay tuition. There is an opportunity for several students to defray a part of their expenses by work. Special courses of one year and of two years are offered. There is also a six weeks' dairy school, the attendance at which is limited to 50.

VIRGINIA.—Virginia Agricultural and Mechanical College (Virginia Polytechnic Institute), Blacksburg. J. M. McBryde, president. Besides the regular course, this institution offers a two-year short course in agriculture. Candidates for admission must be proficient in English grammar, physical geography, history of Virginia and of the United States, arithmetic, and algebra to quadratics.

Tuition is $30 a year, and the total expenses of a session, including the cost of uniform, are estimated at $185.50. The State legislature has provided that a number of students, double the number of members of the house of delegates, making 200, shall have the privilege of attending the college free of tuition. These State students are selected by the school trustees of the various counties, cities, and election districts.

The Hampton Normal and Agricultural Institute, Hampton. H. B. Frissell, president. This institution is for colored persons and Indians. The academic course in this institution requires three years for completion. There are trade and agricultural courses for undergraduates requiring three years, and a three-year postgraduate course in agriculture. Applicants must be able to read well in the third reader; to write in a fair hand a correct paragraph or letter in simple English, properly capitalized, punctuated, and spelled; to make good figures, and to pass a satisfactory examination in arithmetic to percentage.

All students on entering are required to deposit $10. The expense for books varies from $4 to $7 a year. Board, including washing, fuel, lights, medical attendance, and a limited amount of drugs, is $10 per month. Applicants for admission who are without means to pay the $10 a month in cash may be admitted to the night school as work students. Young men and women who are good workers may in this way, by working all day and attending evening classes for a year or more, earn not only their board, but a balance in the school treasury with which to pay a part of their expenses in the day or trade schools.

Tuition is free. The school endeavors to give each pupil a certain amount of work monthly toward the payment of his expenses. In most cases able-bodied, good workers, especially mechanics, can earn as much as $5 a month in the day school, but this is not guaranteed.

WASHINGTON.—Washington Agricultural College and School of Science, Pullman. E. A. Bryan, president. Besides the regular courses this institution offers a two-year short course in agriculture, a course of one term in dairying, and a three-year course in veterinary science. Candidates for admission to the freshman class must have a thorough mastery of the common-school branches and be prepared in algebra through quadratics, plane geometry, general history, civil government, physics, elementary botany, composition and rhetoric, and English classics. Chemistry may be accepted in lieu of physics, and geology or zoology for botany under certain conditions. For those who can not meet these requirements there is a preparatory course of three years.

Tuition is free to residents of the State. Others pay $20 a year. The college does not provide table board, but all students rooming in the college dormitory are required to take their meals at a club managed by a committee of the faculty, while the cost is about $2.50 a week, or less. The charge for rooms, including heat and light, is from $10 to $12 a term. The college offers a free scholarship for each county of the State, to be awarded by its board of county commissioners, such scholarship to entitle its holder to free room rent and exemption from all college fees. The college offers students a limited amount of paid labor.

WEST VIRGINIA.—West Virginia University, Morgantown. J. H. Raymond, president. Among the courses offered by this institution are the following: (1) The regular four-year course, leading to the degree of B. S. Agr.; (2) a two-year course, leading to the degree of B. Agr.; (3) a one-year course; (4) a special twelve weeks' course, so arranged that students may complete the one-year course in three winter quarters; and (5) a special twelve weeks' course in veterinary science and stock breeding and feeding.

For admission to the four-year course the applicant must be prepared in 39 out of 77 courses in 37 specified subjects. A course represents the amount of work done by a class meeting five times a week for twelve weeks. The requirements for admission to the two-year course are 24 such courses. For those who can not meet the entrance requirements there is a preparatory school.

Tuition is free to residents of the State. To others a charge of $12.50 per quarter of twelve weeks is made. All students pay a matriculation fee of $5 on entrance and a contingent fee of $2 per quarter. Room and board may be obtained in the city at from $3 to $4 a week. The university has made arrangements with a well-known house of agricultural publishers in New York by which students may obtain the agricultural books required in the course at greatly reduced rates.

The West Virginia Colored Institute, Institute. J. McH. Jones, president. Applicants for admission to the academic course must have completed the work in the preparatory course, or its equivalent. The subjects taught in the three-year preparatory course include, among others, arithmetic, grammar, geography, and United States history. Tuition is $1 per term, and board $7 a month. Books may be purchased at the institution at cost.

WISCONSIN.—College of Agriculture of the University of Wisconsin, Madison. C. K. Adams, president. Besides the regular four-year course, this institution offers a short course covering two terms of fourteen weeks each, and a dairy course of twelve weeks. The institution also offers a special graduate course in agriculture. For admission to the four-year course the candidate must be prepared in English grammar, arithmetic, algebra through quadratics, plane and solid geometry, political and physical geography, history of the United States, physics, physiology, and botany, and two years of German or French. No examinations are required for entrance to the short course, but applicants must be at least 16 years of age and have a good common-school education. Applicants for admission to the dairy course must have had four months' experience in a creamery or cheese factory before entering.

In all these courses tuition is free to residents of the State. In the graduate and four-year courses nonresidents pay $25 per semester, in the short course $20 per term, and in the dairy course $30. There are also various laboratory fees.

WYOMING.—College of Agriculture of the University of Wyoming, Laramie. E. E. Smiley, president. Besides the regular course, this institution offers one and two year courses. There is a preparatory department, to which students may be admitted on passing examinations in arithmetic, English grammar, United States history, descriptive geography, and physiology.

Tuition is free. Board and room can be obtained with private families for $17 a month and upward. Those who join the university boarding club can bring their living expenses down to $14 a month. The university and vicinity offer considerable opportunities for partial self-support.

## NOTES REGARDING DEPARTMENT PUBLICATIONS.

The publications of the U. S. Department of Agriculture are mainly of three general classes:

I. Publications issued annually, comprising the Yearbooks, the Annual Reports of the Department, the Annual Reports of the Bureau of Animal Industry, and the Annual Reports of the Weather Bureau.

II. Other Departmental reports, divisional bulletins, etc. Of these, each bureau, division, and office has its separate series in which the publications are numbered consecutively as issued. They comprise reports and discussions of a scientific or technical character.

III. Farmers' bulletins, divisional circulars, reprinted Yearbook articles, and other popular papers.

The publications in Class I are distributed by the Department and by Senators and Representatives in Congress. For instance, of the 500,000 copies of the Yearbook usually issued, the Department is only allotted 30,000, while the remaining 470,000 copies are distributed by Members of Congress. The Department's supply of the publications of this class is, therefore, limited, and consequently has to be reserved almost exclusively for distribution to its own special correspondents, and in return for services rendered.

The publications of Class II are not for distribution by Members of Congress, and they are not issued in editions large enough to warrant free general distribution by the Department. The supply is used mainly for distribution to those who cooperate with the Department or render it some service, and to educational and other public institutions. A sample copy of this class of publications can usually be sent on application, but aside from this, the Department generally finds it necessary to refer applicants to the Superintendent of Documents, of whom further mention is made below.

The publications of Class III treat in a practical way of subjects of particular interest to farmers. They are usually issued in large editions, and are for free general distribution by the Department. The farmers' bulletins are also for distribution by Senators and Representatives in Congress, to each of whom is furnished annually, according to law, a quota of several thousand copies for distribution among his constituents.

A limited supply of nearly all the publications in Classes I and II is, in compliance with the law, placed in the hands of the Superintendent of Documents for sale at cost of printing. Application for these should be addressed to the Superintendent of Documents, Union Building, Washington, D. C., and should be accompanied by postal money order payable to him for the amount of the price. No postage stamps or private checks should be sent. The Superintendent of Documents is not permitted to sell more than one copy of any public document to the same person. The Public Printer may sell to one person any number not to exceed 250 copies if ordered before the publication goes to press.

The Secretary of Agriculture has no voice in designating the public libraries which shall be depositories of public documents. Of the distribution of documents to such depositories, including the publications of this and all other Departments of the Government, the Superintendent of Documents has full charge.

For publications of the Weather Bureau requests and remittances should be directed to the Chief of the Weather Bureau.

The Department has no list of persons to whom all publications are sent. A monthly list is issued on the first day of each month giving the titles of all publications issued during the previous month with all the explanations necessary to enable applicants to order intelligently. This list will be mailed regularly to all who apply for it. The Department also issues and sends out to all who apply for them a complete list of all publications of which the Department has a supply for free distribution, and a similar list of all the Department's publications for sale by the Superintendent of Documents.

## PUBLICATIONS ISSUED JANUARY 1, 1900, TO DECEMBER 31, 1900.

The following publications were issued by the United States Department of Agriculture during the year January 1, 1900, to December 31, 1900. Those to which a price is attached, with the exception of publications of the Weather Bureau, must be obtained of the Superintendent of Documents, Union Building, Washington, D. C., to whom are turned over all copies not needed for official use, in compliance with section 67 of the act providing for the public printing and binding and the distribution of public documents. Remittances should be made to him by postal money order. Weather Bureau publications to which a price is attached must be obtained from the Chief of that Bureau. Applications for those that are for free distribution should be made to the Secretary of Agriculture, Washington, D. C.:

### OFFICE OF THE SECRETARY.

| | Copies. |
|---|---|
| Report of the Secretary for 1900 | 12,500 |
| The Culture of Tobacco. Farm. Bul. 82. Reprint | 30,000 |
| The Work of the Agricultural Experiment Stations on Tobacco. Report No. 63. 5 cents | 3,500 |
| Arbor Day: Its History and Observance. Reprint | 1,000 |
| Physiological Studies of Connecticut Leaf Tobacco. Report No. 65. 5 cents | 5,000 |
| Marketing Farm Produce. Farm. Bul. 62. Reprint | 15,000 |
| Work of the Breeder in Improving Live Stock. Reprint from Yearbook, 1899 | 100 |
| Development of Transportation in the United States. Reprint from Yearbook, 1899 | 100 |
| Sheep and Wool: A Review of the Progress of American Sheep Husbandry. Report No. 66. 5 cents | 5,000 |
| Cooperative Grass and Forage Plant Investigations with State Experiment Stations. Cir. 8 | 2,500 |

### CONGRESSIONAL PUBLICATIONS.

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| Annual Reports of the Department of Agriculture for the fiscal year ended June 30, 1899 | 6,000 |
| Operations of the Bureau of Animal Industry for the Fiscal Year ended June 30, 1899 | 50 |
| Letter from the Acting Secretary of Agriculture presenting a detailed statement of the expenditures of all appropriations for the fiscal year ending June 30, 1899 | 1,722 |
| Third Report on the Investigations of the Agricultural Capabilities of Alaska, 1899 | 1,722 |
| Yearbook of the United States Department of Agriculture, 1899. 75 cents | 500,000 |
| — Special edition for distribution at Paris Exposition | 5,000 |

| | Copies. |
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| Field Operations of the Division of Soils, with accompanying papers. Report No. 64. 95 cents | 14,722 |
| Report on the Big Trees of California | 500 |
| Progress of the Beet-Sugar Industry in the United States in 1899, with supplementary report on Cane-Sugar Industry of Hawaiian Islands | 8,000 |
| A Primer of Forestry. Part I. The Forest. Bul. 24, Division of Forestry. Second edition. 35 cents | 35,000 |
| Peach Leaf Curl: Its Nature and Treatment. Bul. 20, Division of Vegetable Physiology and Pathology. 30 cents | 20,000 |

DIVISION OF ACCOUNTS AND DISBURSEMENTS.

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| Report of the Chief of the Division of Accounts and Disbursements for 1899 | 200 |

DIVISION OF AGROSTOLOGY.

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| New or Little Known Mexican Grasses. Cir. 19 | 1,500 |
| Experiments with Forage Plants in Ontario. Cir. 20. With reprint | 8,000 |
| Cooperative Range Grass and Forage Plant Experiments at Highmore, S. Dak. Cir. 21 | 10,000 |
| Grass and Forage Plant Investigations on the Pacific Coast. Cir. 22 | 3,000 |
| Saltbushes. Farm. Bul. 108 | 20,000 |
| Report of the Agrostologist for 1899 | 300 |
| The Soy Bean as a Forage Crop. With an Appendix on Soy Beans as Food for Man. Farm. Bul. 58. Revised edition. Reprint | 20,000 |
| Studies on American Grasses. The North American Species of Chætochloa. Bul. 21. 5 cents | 3,000 |
| Cowpeas. Farm. Bul. 89. Two reprints | 40,000 |
| Cooperative Experiments with Grasses and Forage Plants. Bul. 22. 15 cents | 10,000 |
| Progress of Experiments in Forage Crops and Range Improvement at Abilene, Tex. Cir. 23 | 7,000 |
| Cowpeas and Corn for Silage and Fodder. Cir. 24 | 6,000 |
| Alfalfa, or Lucern. Farm. Bul. 31. Reprint | 20,000 |
| Meadows and Pastures. Formation and Cultivation in the Middle Eastern States. Farm. Bul. 66. Revised edition. Reprint | 20,000 |
| Economic Grasses. Bul. 14. Revised edition. 10 cents | 5,000 |
| The Structure of the Caryopsis of Grasses with Reference to Their Morphology and Classification. Bul. 19. Revised edition. 10 cents | 1,000 |
| American Grasses—III. (Illustrated.) Descriptions of the Tribes and Genera. Bul. 20. With revised edition. 15 cents | 2,000 |
| Turkestan Alfalfa. Cir. 25. With reprint | 20,000 |
| Rescue Grass. Cir. 26 | 5,000 |
| Cattle Ranges of the Southwest: A History of the Exhaustion of the Pasturage and Suggestions for Its Restoration. Farm. Bul. 72. Reprint | 10,000 |
| Fodder and Forage Plants Exclusive of the Grasses. Bul. 2. Revised edition. 5 cents | 5,000 |
| American Grasses—I. (Illustrated.) Descriptions of the Species. Bul. 7. Third edition. 30 cents | 1,000 |
| Studies on American Grasses. A Revision of the North American Species of Bromus Occurring North of Mexico. Bul. 23. 5 cents | 3,000 |
| Grasses as Sand and Soil Binders. Reprint from Yearbook, 1894. Reprint | 2,000 |
| Progress of Economic and Scientific Agrostology. Reprint from Yearbook, 1899 | 2,000 |
| Succulent Forage for the Farm and Dairy. Reprint from Yearbook, 1899 | 3,000 |
| Southern Forage Plants. Farm. Bul. 102. Reprint | 10,000 |
| Millets. Farm. Bul. 101. Reprint | 15,000 |
| Sorghum as a Forage Crop. Farm. Bul. 50. Reprint | 15,000 |
| Agrostological Notes. Cir. 27 | 2,000 |

BUREAU OF ANIMAL INDUSTRY.

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| Scales of Points in Use in the United States for Judging the Dairy Breeds of Cattle. Cir. 27. Revised edition | 2,000 |
| Breeds of Dairy Cattle. Farm. Bul. 106. Three reprints | 60,000 |
| The Dairy Herd: Its Formation and Management. Farm. Bul. 55. Two reprints | 35,000 |

| | Copies. |
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| Report of the Chief of the Bureau of Animal Industry for 1899 | 1,200 |
| Letters Relating to the Distribution of Vaccine. Cir. 28 | 10,000 |
| Officials, Associations, and Educational Institutions Connected with the Dairy Interests of the United States for the Year 1900. Cir. 29 | 6,000 |
| Hog Cholera and Swine Plague. Farm. Bul. 24. Three reprints | 55,000 |
| Some Essentials in Beef Production. Farm. Bul. 71. Two reprints | 30,000 |
| Notes Upon Dairying in California and the Export of California Butter to the Orient. Bul. 24. With reprint. 5 cents | 13,000 |
| Butter Making on the Farm. Farm. Bul. 57. Three reprints | 45,000 |
| Ducks and Geese: Standard Breeds and Management. Farm. Bul. 64. Two reprints | 40,000 |
| Hog Raising in the South. Farm. Bul. 100. Reprint | 30,000 |
| Butter Substitutes. Reprint from the Yearbook for 1895. Reprint | 10,000 |
| Raising Sheep for Mutton. Farm. Bul. 96. Two reprints | 30,000 |
| Directions for the Use of Blackleg Vaccine. Cir. 23. Second revision, with two reprints | 35,000 |
| Rabies in the District of Columbia. Cir. 30. Revised edition | 5,000 |
| Sheep Scab: Its Nature and Treatment. Bul. 21. Revised edition. 15 cents. | 10,000 |
| Blackleg: Its Nature, Cause, and Prevention. Cir. 31, with revised edition. | 10,000 |
| Some Examples of the Development of Knowledge Concerning Animal Diseases. Reprint from Yearbook, 1899 | 500 |
| Administrative Work of the Federal Government in Relation to the Animal Industry. Reprint from Yearbook, 1899 | 500 |
| Dairy Development in the United States. Reprint from Yearbook, 1899 | 8,000 |
| Facts about Milk. Farm. Bul. 42. Two reprints | 25,000 |
| Rabies. Report of the Committee on Public Health of the Medical Society of the District of Columbia. Bul. 25. 5 cents | 3,000 |
| Standard Varieties of Chickens. Farm. Bul. 51. Two reprints | 65,000 |
| Care of Milk on the Farm. Farm. Bul. 63. Two reprints | 45,000 |
| Report upon Experimental Exports of Butter, 1898–99. Reprint from Sixteenth Annual Report | 12,000 |
| Statistics of Oleomargarine, Oleo Oil, and Filled Cheese. Reprint from Sixteenth Annual Report | 6,000 |
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| Experiments with Texas Fever and Southern Cattle Ticks. Reprint from Sixteenth Annual Report | 2,000 |
| Foreign Markets for Eggs and Poultry. Reprint from Sixteenth Annual Report | 2,000 |
| National and State Dairy Laws. Bul. 26. 10 cents | 1,000 |
| Our Present Knowledge of the Kidney Worm of Swine. Reprint from Sixteenth Annual Report | 5,000 |

DIVISION OF BIOLOGICAL SURVEY.

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| Farm. Bul. 54. Two Reprints | 50,000 |
| Report of the Acting Chief of the Division of Biological Survey for 1899 | 300 |
| North American Fauna, No. 17. Revision of American Voles of the Genus Microtus. 10 cents | 3,000 |
| Legislation for the Protection of Birds Other than Game Birds. Bul. 12. With reprint. 10 cents | 5,000 |
| Directory of State Officials and Organizations Concerned with the Protection of Birds and Game. Cir. 28. With reprint | 6,000 |
| Protection and Importation of Birds under Act of Congress Approved May 25, 1900. Cir. 29. With reprint | 6,000 |
| A Review of Economic Ornithology in the United States. Reprint from Yearbook, 1899 | 3,000 |
| Food of the Bobolink, Blackbirds, and Grackles. Bul. 13. 5 cents | 4,000 |
| Wild Animals and Birds which may be Imported without Permits. Cir. 30. | 2,000 |
| North American Fauna, No. 18. Revision of the Pocket Mice of the Genus Perognathus. 10 cents | 3,000 |
| Hawks and Owls from the Standpoint of the Farmer. Reprint from Yearbook, 1894. Reprint | 5,000 |
| North American Fauna, No. 19. Results of a Biological Reconnoissance of the Yukon River Region. 10 cents | 3,000 |
| Information Concerning Game: Seasons, Shipment, and Sale. Cir. 31. With reprint | 15,000 |

| | Copies. |
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| Birds of the Yukon Region, with Notes on Other Species. Reprint from North American Fauna, 19 | 150 |
| Laws Regulating the Transportation and Sale of Game. Bul. 14. 10 cents | 5,000 |

DIVISION OF BOTANY.

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| Horse-Radish Culture in Bohemia. Cir. 20. With reprint | 4,500 |
| Yams in the West Indies. Cir. 21 | 5,000 |
| Report of the Botanist for 1899 | 500 |
| Russian Cereals Adapted for Cultivation in the United States. Bul. 23. 5 cents | 5,000 |
| Bur, or Globe Artichokes. Cir. 22 | 5,000 |
| Weeds, and How to Kill them. Farm. Bul. 28. Two reprints | 45,000 |
| Rice Culture in the United States. Farm. Bul. 110 | 20,000 |
| Inventory No. 5 of Foreign Seeds and Plants Imported by the Department of Agriculture and for Distribution through the Section of Seed and Plant Introduction. Nos. 1901–2700 | 1,500 |
| The Lebbek or Siris Tree. Cir. 23 | 5,000 |
| Red Clover Seed. Cir. 24 | 12,000 |
| Inventory No. 6. Foreign Seeds and Plants Collected in Austria, Italy, and Egypt by the Hon. Barbour Lathrop and Mr. David G. Fairchild for the Section of Seed and Plant Introduction | 1,500 |
| The Germination of Seeds as Affected by Certain Chemical Fertilizers. Bul. 24. 5 cents | 4,000 |
| The Seed of Beardless Brome Grass. Cir. 25 | 10,000 |
| Egyptian Cotton in the United States. Cir. 26 | 5,000 |
| Thirty Poisonous Plants of the United States. Farm. Bul. 86. Reprint | 30,000 |
| The Farmers' Interest in Good Seed. Farm. Bul. 111. With reprint | 35,000 |
| Notes on Useful Plants of Mexico. Reprint from Contributions from the U. S. National Herbarium, Vol. V, No. 4 | 3,000 |
| Hop Culture in California. Farm. Bul. 115 | 30,000 |
| Wild Garlic. Cir. 9. Revised edition | 5,000 |
| Canada Thistle. Cir. 27 | 5,000 |
| Contributions from the U. S. National Herbarium. Vol. V, No. 5. The Plant Covering of Ocracoke Island [N. C.]. 5 cents | 5,000 |
| Crimson Clover Seed. Cir. 18. Revised edition, with reprint | 46,500 |
| Rubber Culture for Porto Rico. Cir. 28 | 8,000 |
| The Present Status of Rice Culture in the United States. Bul. 22. Reprint. 10 cents | 2,000 |
| Seed Selling, Seed Growing, and Seed Testing. Reprint from Yearbook, 1899 | 2,000 |
| Inventory No. 7. Foreign Seeds and Plants Imported for Distribution | 1,500 |
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| Snow and Ice Bulletin, January to December, 1900 | 37,385 |
| Daily Weather Map, January to December, 1900 | 6,115,477 |

## REVIEW OF WEATHER AND CROP CONDITIONS, SEASON OF 1900.

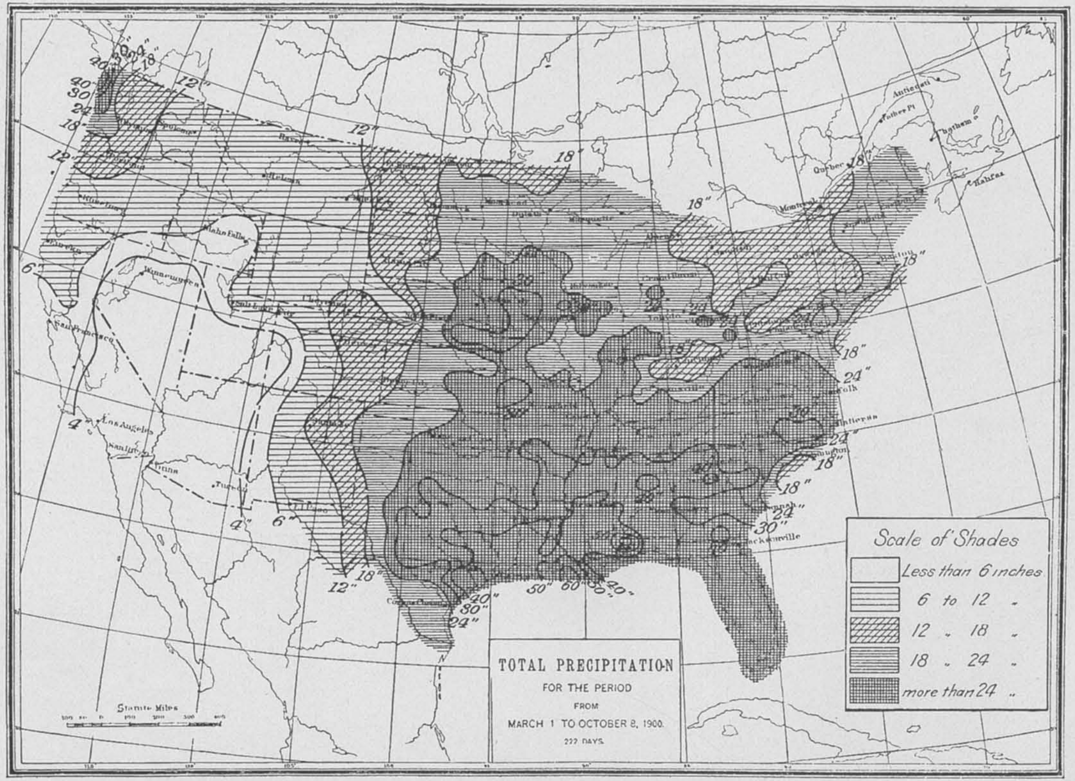
The accompanying tables and diagrams (see figures 86 and 87, pages 698 to 699, and Plates LXXXV, LXXXVI, and LXXXVII) show how the temperature and rainfall over the United States during the crop season of 1900 from week to week compares with normal conditions of corresponding periods of former years. In the large tables are given departures from normal temperature and precipitation (in degrees Fahrenheit and inches and hundredths, respectively) for Weather Bureau stations, by months, from January 1 to March 31, and by weeks ending Mondays at 8 a. m., seventy-fifth meridian time, from April 9 to October 8. The diagrams exhibit the departures from normal, by districts, for the same period, and the three plates show respectively the departures from normal temperature, the total precipitation, and the departures from normal precipitation during the crop season.

### CONDITIONS FROM JANUARY TO APRIL.

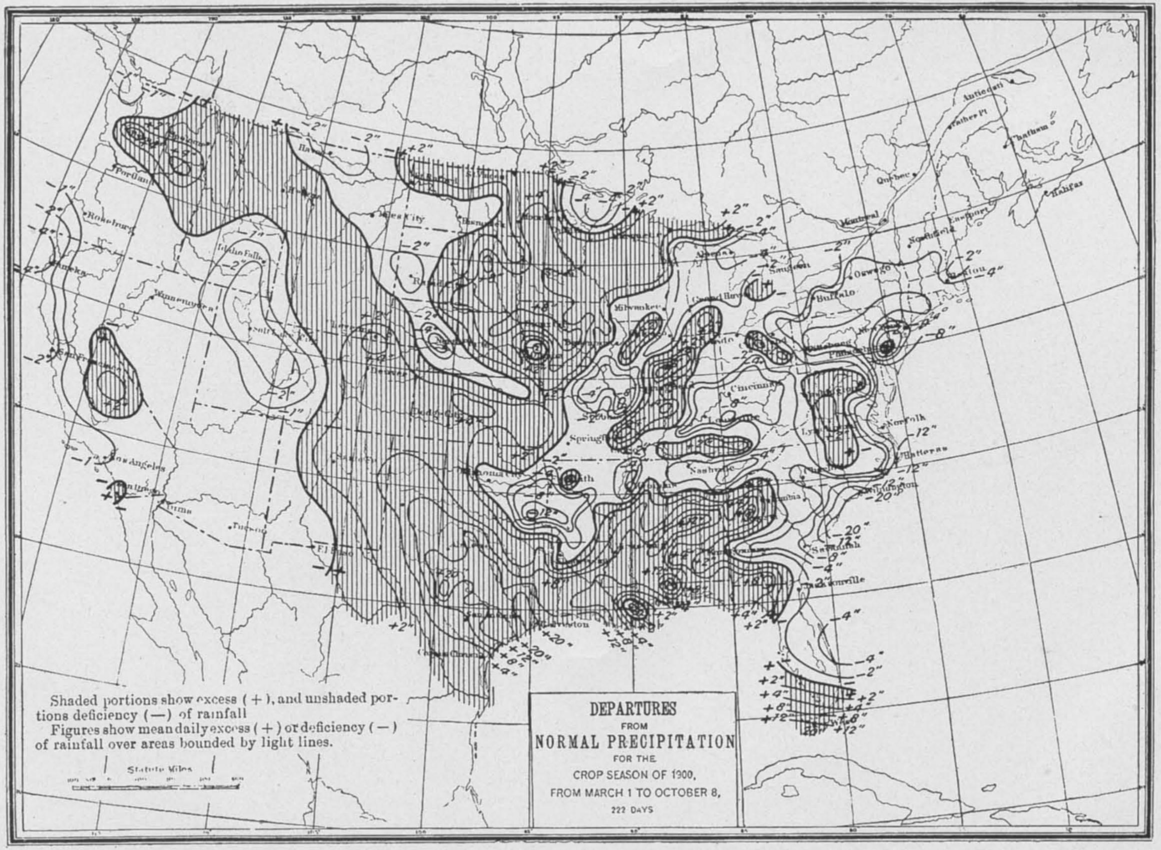
The month of January, 1900, was milder than usual in all parts of the country, with the exception of a portion of the South Atlantic and East Gulf States, including the Florida Peninsula, where the average temperature was slightly below the normal. From the Upper Lake region westward to Idaho, including the Rocky Mountain slope and Lower Missouri Valley, the month was exceptionally mild, the temperature excess ranging from 6° to 18°, being most marked in northern Minnesota, the Dakotas, and eastern Montana. On the Pacific coast the month generally averaged from 3° to 16° warmer than usual, except in central California, where the excess was somewhat less marked. As a whole the precipitation during January was much below the average, although portions of the Gulf and South Atlantic States, Lower Lake region, New England, and limited areas in the Upper Mississippi Valley received more than the usual amount. Generally throughout the central valleys, Upper Lake region, and in the Rocky Mountain districts the month was marked by exceptionally light precipitation, portions of the middle Rocky Mountain slope and Missouri Valley receiving no appreciable amount; and while a marked deficiency existed on the Pacific coast, from 2 to more than 10 inches fell along the immediate coast from central California northward. In portions of eastern Texas and southern Louisiana and along the South Atlantic and New England coasts there was more than the usual amount of precipitation, the excess over limited areas ranging from 1 to 2 inches. At the close of this month there was but little snow on the ground except in the Lake region and New England, the northern portions of which were covered to depths ranging from 3 to 16 inches. The weather conditions during January were generally favorable for winter wheat, except in New York, Pennsylvania, North Carolina, Ohio, and Michigan, although the extremely cold weather of the first and last days of the month, especially the latter period, was damaging in nearly all sections, as the crop had little or no snow protection. With the exception of Ohio and Michigan, and a limited area in Indiana, winter wheat was generally in excellent condition prior to the cold at the close of the month. Unfavorable reports continued from Ohio and Michigan. In the first-named State the plant was in very tender condition, with no snow protection, and in the latter State it was small and the fields looked poor, especially on high lands. Injury by Hessian fly was quite generally reported. On the Pacific coast the weather was very favorable and the


Shaded portions show excess (+), and unshaded portions deficiency (—) of temperature.
Figures show mean daily excess (+) or deficiency (—) of temperature over areas bounded by light lines.
AVERAGE DAILY DEPARTURES
FROM
NORMAL TEMPERATURE
FOR THE
CROP SEASON OF 1900,
FROM MARCH 1 TO OCTOBER 8.

Plate LXXXVI.




Yearbook U. S. Dept. of Agriculture, 1900.


Shaded portions show excess (+), and unshaded portions deficiency (—) of rainfall
Figures show mean daily excess (+) or deficiency (—) of rainfall over areas bounded by light lines.
Statute Miles
DEPARTURES
FROM
NORMAL PRECIPITATION
FOR THE
CROP SEASON OF 1900,
FROM MARCH 1 TO OCTOBER 8,
222 DAYS

crop was unusually promising. Some plowing was done in West Virginia, Illinois, Kansas, and Oklahoma during the mild weather of this month.

Over the western portions of the plateau region, the Pacific coast districts, and southern New England February averaged milder than usual, the temperature excess being very slight except over the western portions of the central and northern plateau region and southern California, where it ranged from 3° to 5° per day. Over portions of the southeastern Rocky Mountain slope and in eastern South Dakota nearly normal temperature conditions prevailed, but generally throughout the central valleys, Lake region, Middle and South Atlantic and Gulf States the month was colder than usual, the average daily deficiency in temperature being greatest in the Lower Missouri, Central Mississippi, and Ohio valleys, Tennessee, and over the interior portions of the South Atlantic and East Gulf States, where it generally ranged from 6° to 8° per day. Except along the immediate South Atlantic coast there was more than the usual amount of precipitation from the Gulf coast northeastward to the St. Lawrence Valley, also in the Lake region, Central Mississippi and Lower Missouri valleys, and over the middle Rocky Mountain slope. The precipitation amounted to from 6 to more than 12 inches over portions of the East Gulf and South Atlantic States, and from 6 to 10 inches over the greater part of New England. Generally throughout the Pacific coast and plateau regions, the Upper Missouri Valley, including Minnesota and northern Wisconsin, and over an area extending from the Rio Grande Valley northeastward to the Central Ohio Valley, the precipitation was below the average. Along the immediate north Pacific coast, although the precipitation ranged from 4 to 10 inches, it was decidedly below the average, except near the mouth of the Columbia River, where it was excessive. Throughout California the precipitation was much below the average, more than half the State receiving less than 0.50 inch, and a large area over the southern portion no appreciable amount. At the close of this month the ground was covered with snow from the middle Rocky Mountain slope eastward over the Lower Missouri and Central Mississippi valleys, the southern limit extending from northern Arkansas northeastward over the Ohio Valley to the New England coast, the depths ranging from 3 to 18 inches from the Lower Missouri Valley northeastward over the Central Mississippi Valley and greater part of the Lake region and New England. The absence of snow protection over the principal winter wheat States during the greater part of February, with alternate freezing and thawing, left wheat as a whole at the close of the month in much less favorable condition than at the end of the preceding month. The reported condition of the crop at the end of February was, however, generally satisfactory in most sections outside of the Middle States, Ohio, Michigan, and portions of Indiana, Missouri, and Kansas. In Michigan and Ohio many reports of winterkilling were received, indicating a more unfavorable condition than at any time during the winter. On the North Pacific coast favorable reports were received from Washington, Oregon, and northern and central California, although the crop in eastern Washington sustained some injury as a result of the cold at the close of the month. In southern California, where there had been an almost total absence of rain, the crop, especially the early sown, was suffering seriously from drought.

The temperature during March averaged nearly normal in the Central and East Gulf States, but elsewhere east of the Mississippi the month was colder than usual, the temperature deficiency ranging from 3° to 6° in the Lake region, New England, and Ohio and Upper Mississippi valleys. Throughout the Pacific coast and plateau region and over the States of the eastern Rocky Mountain slope the month was much milder than usual, especially over the central and northern plateau regions, where the temperature excess ranged from 3° to 8° per day. A marked feature of March was the continued prevalence throughout the month of mild temperature conditions in the Rocky Mountain plateau and Pacific coast districts, while abnormally low temperatures were equally persistent from the Upper Mississippi Valley eastward to the Atlantic coast. Over much the greater part of the country the precipitation during March was below the average. There was, however, more than the average amount in Florida, central and southern Texas, over an area extending from northern Alabama to central Virginia, in northern New England, New York, and over a narrow area extending from the Upper Mississippi Valley to the North Pacific coast. Over portions of Texas, Florida, and Alabama, Georgia, and New England the precipitation ranged from 6 to more than 8 inches. Throughout the central valleys the total precipitation was for the most part less than 2 inches, although limited areas received more. The month was characterized by unusually light precipitation throughout the central and southern plateau regions, and in Oregon and California, where it was also generally deficient in January and February. East of the Mississippi River, except in the Southern States, the season was generally backward and unfavorable for farm work, with excessive rains in portions of the Gulf States, and heavy snow in portions of the Lake region and New England. On the Pacific slope

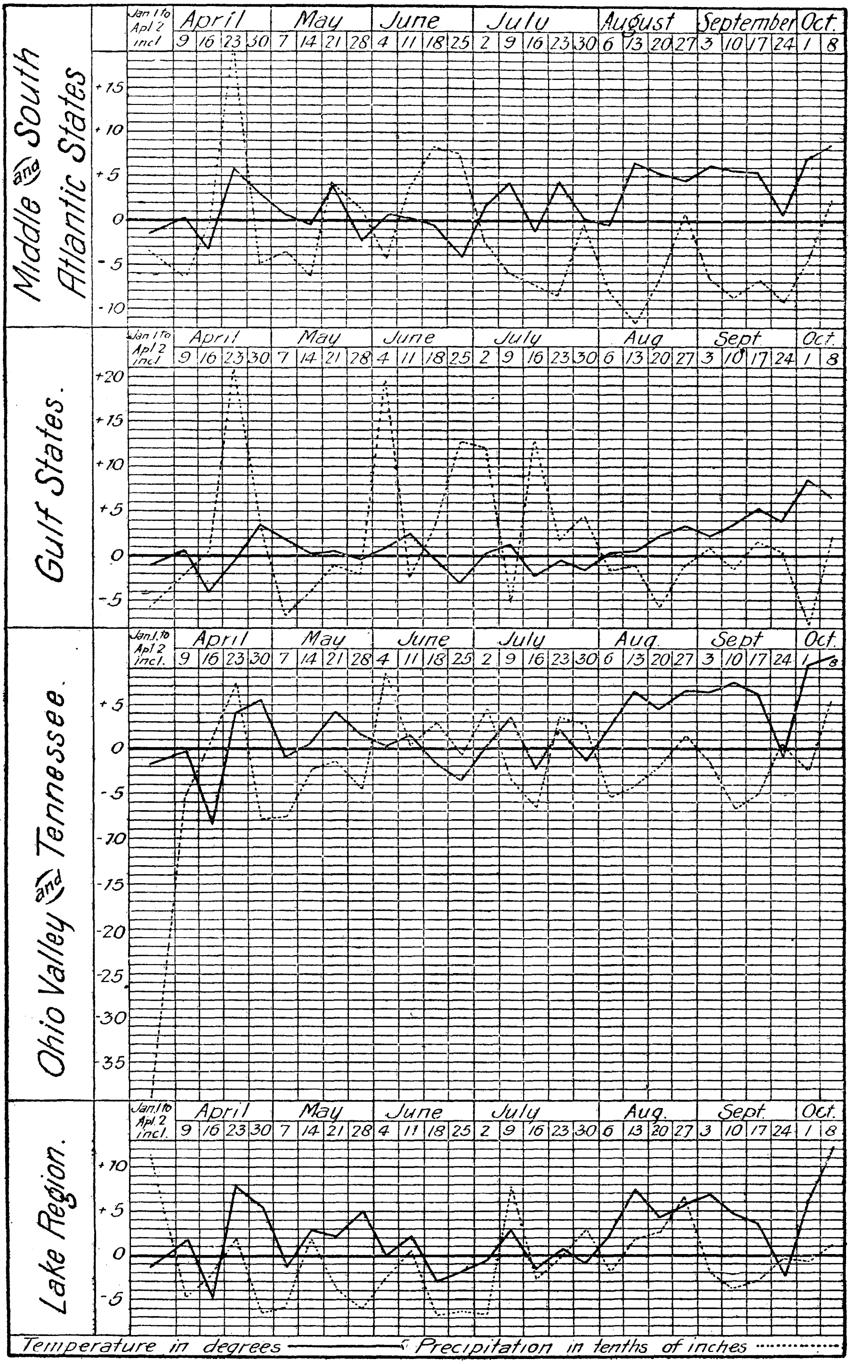



FIG. 86.—Temperature (degrees Fahr.) and precipitation (inches) departures for the season of 1900 from the normal of many years for the Middle and South Atlantic States, the Gulf States, the Ohio Valley and Tennessee, and the Lake region.

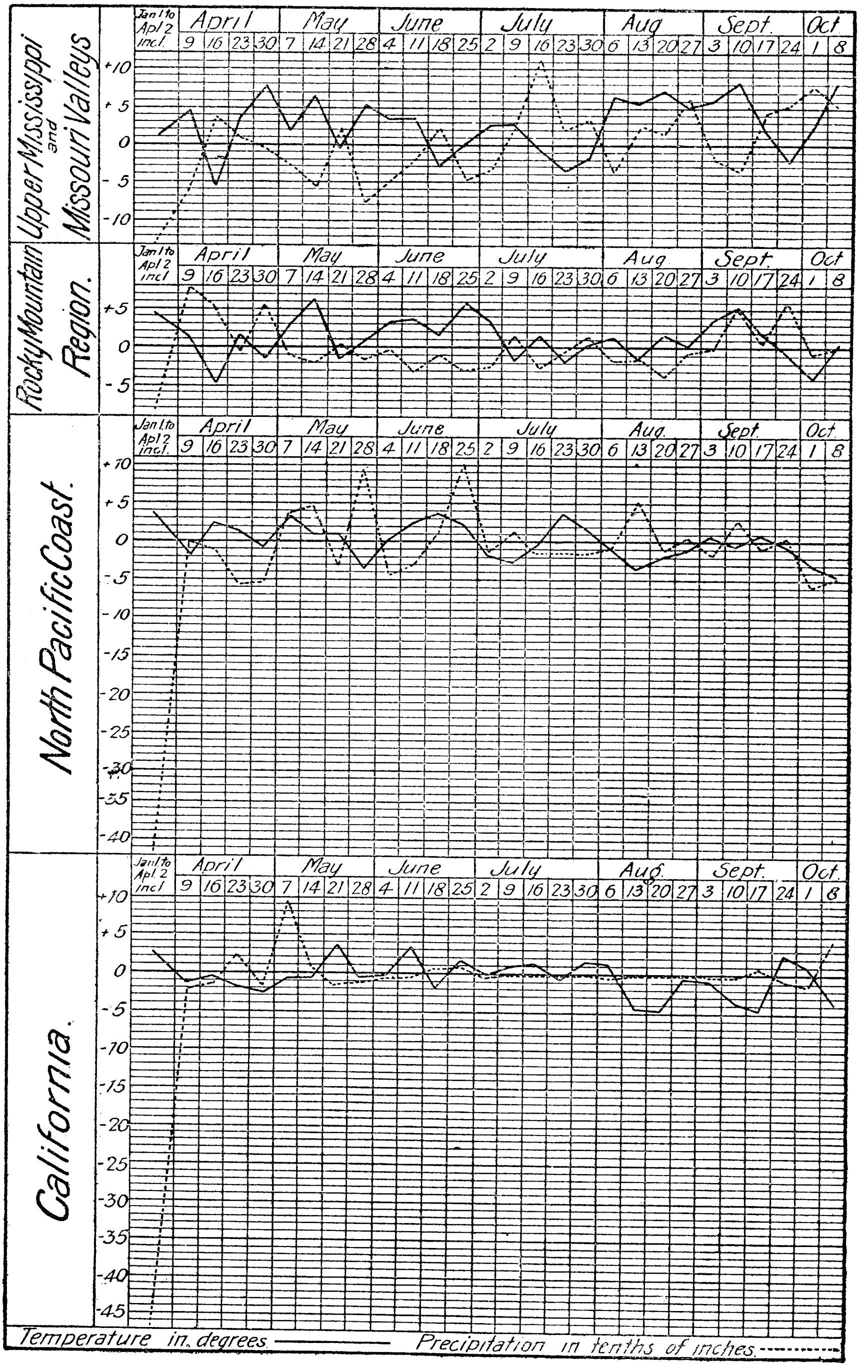



FIG. 87.—Temperature (degrees Fahr.) and precipitation (inches) departures for the season of 1900 from the normal of many years for the Upper Mississippi and Missouri valleys, the Rocky Mountain region, the North Pacific Coast, and California.

and in the Rocky Mountain districts exceptionally favorable conditions prevailed, and farming operations progressed rapidly. At the close of March unfavorable reports regarding winter wheat were received from Wisconsin, Michigan, Ohio, Pennsylvania, New Jersey, and portions of Missouri, Illinois, Kentucky, and Maryland; elsewhere the crop was in promising condition. Outside of a limited area in southern California, winter wheat on the Pacific coast was well advanced and very promising. Some spring wheat had been sown over the southern portions of the spring-wheat region, and also in Montana, where the season was unusually advanced. Corn was being planted in the Southern States, some as far north as North Carolina. In southern Texas the bulk of the crop had been planted. Oats were being sown in Kansas, Missouri, Ohio, and Kentucky, and were coming up to good stands in Oklahoma, Texas, Arkansas, Tennessee, and Mississippi. Reports of winterkilling of the fall crop were received from Virginia and Georgia. Cotton planting had begun over the southern portion of the cotton region. The soil was in good condition, and considerable plowing had been done except in the more northerly sections, where frost still remained in the ground, and in portions of New Jersey, Maryland, West Virginia, Virginia, Tennessee, and North Carolina, where this work had been delayed by wet weather.

### SUMMARY OF THE SEASON BY WEEKS.

By weeks ending with Monday from April 9 to October 1 the crop conditions may be summarized as follows:

*April 9.*—The general absence of rain with mild temperature conditions over the northern districts from Montana and Wyoming eastward to the Atlantic coast, including the lower Missouri and central Mississippi valleys, was favorable for farming operations. The season, however, continued late in the lower lake region, Middle Atlantic States, and New England, the northern portion of the last-named district being still covered with unusual depths of snow. The weather was too cool for best results in the South Atlantic and Gulf States, and heavy rains proved destructive in Texas. The week was also abnormally cool in the southern plateau region and California, where more or less damaging frosts occurred. Frosts also occurred as far south as the Carolinas, Georgia, and the central Gulf States, causing no material damage, however, except in the Carolinas. From Kansas and Missouri southward corn planting was unusually well advanced and progressing rapidly, planting being nearly finished in Oklahoma and southern Kansas, the early planting being up as far north as the southern portions of Missouri and Kansas. Some corn had been planted in southern Illinois and Tennessee and North Carolina, but none had been planted farther northward in the districts east of the Mississippi. Poor stands were reported from portions of Georgia and Mississippi, but good stands were reported from Alabama and Texas. In the last-named States, however, much damage had been done by washing rains. Very unfavorable reports as to winter wheat were received from Michigan, Indiana, Ohio, Pennsylvania, and New York. In eastern Kansas and Illinois it was suffering for rain. In Nebraska, Kansas, and Missouri, and from Oklahoma eastward over the Mississippi Valley to the Atlantic coast the condition of winter wheat was very promising. On the Pacific coast the winter wheat was generally excellent, except in southern California. Cotton planting was general over the southern portion of the cotton belt, and some had been planted in Oklahoma and Arkansas. Planting was well advanced in southern Texas, and extensive preparations for planting had been made throughout the cotton region.

*April 16.*—This week was much too cold and farm work was generally retarded. Temperatures below freezing occurred in nearly all sections north of the northern boundaries of North Carolina, Tennessee, Arkansas, and Oklahoma, the lowest ranging from 10° to 25° below freezing over the northern portion of the lake region and States of the middle and northern Rocky Mountain slope. These unusually low temperature conditions were accompanied by excessive precipitation, much in the form of snow, over the lower Missouri Valley and middle Rocky Mountain slope, and frosts were quite general as far south as the interior portions of the Gulf and South Atlantic States. In Florida and on the Pacific coast the weather conditions were more favorable. Corn planting continued in the Southern States, but farther north little progress was made, although preparations for planting were active. A small acreage of corn was planted in Tennessee and some as far north as Virginia. The condition of winter wheat was about as reported in the previous week. Over the southern portion of the winter-wheat belt it was very promising, while in the more northerly sections the previously reported unfavorable conditions were practically unchanged, except further deterioration in Illinois and Ohio. On the Pacific coast winter wheat continued very promising, except in southern California. Spring-wheat seeding was nearing completion and the early sown was coming up over the southern portion of the spring-wheat region. Most of the oat crop had been seeded in the States of the central valleys, and seeding was in progress in the Middle Atlantic States, Minnesota, and South Dakota. In the more southerly sections good stands were reported. Slow progress was made with cotton planting during this week, but preparations were extensive. Some cotton was planted in the Carolinas, but none in Tennessee. Moisture was needed in Georgia, while portions of Texas suffered from overflows. In the last-named State poor stands of the early planting were reported. Warm sunshine was generally needed for cotton, especially in the central and western portions of the cotton belt.

*April 23.*—The temperature conditions of this week were generally highly favorable, but excessive rains in the Southern States greatly interfered with farm work and caused destructive floods. Farm work was also retarded as a result of heavy rains in the eastern portions of Kansas and Nebraska and southern Missouri. Rain was much needed in Montana, North Dakota, and over the northern portion of Minnesota. While freezing temperatures occurred in the upper Missouri Valley and middle and northern Rocky Mountain regions, no serious damage was done. The week was not favorable for the rapid progress of corn planting, but preparations for this work were very active in the more northerly sections. Planting was generally retarded where not completed in the Southern States, and also from Kansas and Oklahoma eastward over the central Mississippi Valley, being later than for many years in Tennessee. An improvement in the condition of winter wheat was generally reported, except in Michigan and Wisconsin, where plowing up for other crops continued. With ample moisture and favorable temperature, wheat made rapid growth in the central valleys and Southern States. It was heading in Texas and its condition in Kentucky and Tennessee was exceptionally fine. The favorable outlook on the Pacific coast, except in southern California, continued. Early sown spring wheat was coming up to good stands over the southern portion of the spring-wheat region, and seeding had been nearly completed, except in North Dakota and Montana, where from one-quarter to one-half of the crop was yet to be sown. Rain was quite generally needed for germination over the northern portion of the spring-wheat region. All reports respecting the oat crop were encouraging, seeding being well advanced in the northern sections. The continuous excessive rains over the central and eastern portions of the cotton belt had retarded cotton planting and washed out much of the acreage previously planted. In southern Texas planting was well advanced and it was progressing rapidly in the northern portion of the State. Planting over the northern portion of the eastern part of the cotton belt was unusually delayed.

*April 30.*—The most unfavorable features of this week were the excessive rains in the Southern States and the unseasonably low temperatures over the central and southern plateau and Pacific coast regions. A large part of Texas, including the region of the great flood of June–July, 1899, received from 2 to more than 7 inches of rain, washing out and inundating crops to a great extent over the central and southern portions of the State. Too much rain had generally retarded farm work in the States of the Missouri Valley and middle Rocky Mountain slope, but with general absence of rain and highly favorable temperature from the Missouri Valley eastward to the Atlantic coast, farm work and crops made decided progress, although rain was needed in the Middle Atlantic States and lake region. It was too cool for best results on the Pacific coast, but very beneficial showers occurred in southern California. Eastward of the Mississippi River corn planting and preparations therefor progressed rapidly, planting being in progress as far north as the central portions of Illinois, Indiana, and Ohio, and in West Virginia and Maryland. Some corn was planted in southern Iowa. On account of the wet weather but little corn was planted in Nebraska, and planting was retarded in Missouri and Kansas. In Kansas and Texas and portions of Mississippi, Arkansas, and Alabama much replanting was necessary as a result of overflows. Improvement was generally reported in the condition of winter wheat, except in Michigan and Wisconsin, where farmers continued to plow up wheat fields for other crops. The crop was heading as far north as Tennessee, Arkansas, and Oklahoma. In central and northern California high winds were unfavorable, but the crop was improved by rains in the southern part of the State. All reports indicated that spring wheat was coming up finely and making excellent growth. Seeding was now practically completed except in North Dakota. Except where damaged by heavy rains in Texas, the general outlook for oats was excellent. Seeding was nearing completion in the northern sections and the crop was heading in the Southern States, while some of the early sowing had been harvested in Florida. In the central and eastern portions of the cotton belt cotton planting progressed under more favorable conditions than in the previous week and good stands were quite generally reported. Planting was well advanced over the northern portion of the cotton belt, and the early planting was being cultivated over the southern portions. Great damage had been caused by the rains in central and southern Texas, where much replanting was necessary. In many portions of Texas the bulk of the crop was yet to be planted and seed was reported scarce. Transplanting of tobacco was in progress as far north as North Carolina, and an abundant supply of vigorous plants was generally reported. The reports concerning fruit continued generally favorable, except on the North Pacific coast and in the central and southern plateau regions, where damaging frosts had occurred.

*May 7.*—Rain was now very generally needed northward of the Missouri and Ohio rivers, including Kentucky and portions of the Middle Atlantic States, the lack of moisture being most seriously felt in Michigan and portions of Wisconsin and North Dakota, while a large part of Texas continued to suffer from the effects of the excessive rains of the two preceding weeks. Phenomenally heavy rains for the season occurred in California, especially on the southern coast, causing some damage, but on the whole they were greatly beneficial. The temperature conditions over the southern and central districts west of the Mississippi were highly favorable, but it was much too cool in the lake region, Ohio Valley, the Middle Atlantic States, and New England, where frequent frosts were more or less destructive. The cool, dry weather retarded corn planting in the States of the Ohio and Mississippi valleys and lake region, but very favorable progress was made in the Middle Atlantic States. In the States of the Missouri Valley the conditions were also generally favorable for planting, except in Iowa and Nebraska, where, however, a good start had been made. Some corn had been planted in the Dakotas, but in Minnesota farmers were waiting for warmer weather and rain. In the Southern States the reports concerning corn were generally favorable, except in Florida and portions of Texas. Owing to low temperatures and absence of rain winter wheat made slow progress in the States of the Ohio Valley, and complaints of serious injury by the Hessian fly in Tennessee and South Carolina and Georgia were reported. In the Middle Atlantic States and generally west of the Mississippi wheat made good progress, the reports from the Pacific coast being especially favorable. Some slight damage to spring wheat from frost and high winds was reported from North Dakota, and late sowings in Wisconsin needed rain, but generally throughout the spring-wheat region the crop was doing well. The previously reported favorable outlook for oats continued unimpaired, except slight deterioration in portions of the Ohio and Mississippi valleys, where growth had been checked by cool, dry weather. Cool nights were unfavorable to cotton over the northern portion of the eastern half of the cotton belt, and the heavy rains of the previous weeks in Florida and Texas necessitated extensive replanting. Generally, however, the crop did well, good stands being reported, except in the flooded portions of Florida and Texas; in the last-named State planting had been vigorously pushed where practicable, and was well advanced in the northern portion, but was much behind in the middle and southern portions, where in places the third planting had been rendered necessary by floods. Tobacco plants continued plentiful and were large enough for transplanting in Virginia and Tennessee, the bulk of the crop in South Carolina having been planted. Most of the reports respecting fruit continued encouraging, although portions of the lake region, Ohio Valley, and northern New England experienced very trying temperature conditions.

*May 14.*—Much-needed rains fell in this week over a large part of the area northward of the Ohio and Missouri rivers that suffered for lack of moisture in the previous week. Continued absence of rain, however, intensified the droughty conditions in eastern Montana and North Dakota, and while showers afforded temporary relief in Minnesota more rain was needed there and in portions of Wisconsin. Drought conditions also increased over a large part of the Middle Atlantic States and portions of Tennessee. There was too much rain in Oregon and western Washington, where warm sunshine was needed, especially in the first-named State. The temperature conditions were generally very favorable except in New England, where it was much too cool, and although the temperatures averaged nearly normal in the Gulf States, complaints of the unfavorable effects of cool nights on germination and growth were received from the central and eastern portions. The week was marked by excessively high temperatures for the season in the region between the Upper Missouri River and the Great Lakes, while the lowest temperatures yet recorded in the second decade of May were reported from New England. Frosts, more or less injurious, were very general east of the Mississippi as far south as Tennessee and western North Carolina on the 10th and 11th. Upon the whole, the week was exceptionally favorable to corn. Planting had progressed rapidly in the central and northern districts, and was nearing completion in some of the important corn States of the central valleys; planting in Minnesota and North Dakota was general and had begun in the southern portions of Wisconsin and Michigan. Cool nights checked the growth of corn in the Lower Ohio and Lower Mississippi valleys and portions of the South Atlantic States. Complaints of injury to winter wheat by the Hessian fly continued, and in some sections, namely, Tennessee and Missouri, were more numerous than in the preceding week, but on the whole the crop made favorable progress; it was heading as far north as the Ohio Valley. Excellent reports continued from the Pacific coast, where harvesting and thrashing had begun in the San Joaquin Valley, the earliest in many years. Early-sown spring wheat was generally doing well, but the late sown over the northern portion of the spring-wheat region was suffering much from drought. Reports respecting oats were not so generally favorable, the least favorable reports being from Minnesota and North Dakota and portions of the Middle Atlantic States and Ohio Valley, where the crop was needing rain. Complaints of unfavorable effects of cool nights upon cotton continued from the central and eastern portions of the cotton belt, where planting was nearing completion, but, as a rule, the crop made favorable progress. Over much of the flooded districts of Texas there was an absence of rain, or only light showers, a condition needed for planting and replanting, which work was vigorously crrried on. Much planting remained to be done in the central and southern portions of Texas, and generally the crop in that State was late and irregular. Tobacco plants were reported backward in Kentucky, although plentiful, as elsewhere. Transplanting was finished in South Carolina and some transplanting had been done in Virginia, but none farther northward.

*May 21.*—Abundant rains relieved drought conditions in the Middle Atlantic States, but drought continued in the Upper Missouri Valley, in Minnesota and northern Wisconsin, and the need of rain began to be felt in portions of the East Gulf States and Florida. The temperature conditions on the Pacific coast, in the Upper Missouri Valley, and over the greater part of the country east of the Mississippi River were favorable for rapid growth, especially in the Ohio Valley and Middle and South Atlantic States, although complaints of cool nights were received from Tennessee and the Central Gulf States. From Nebraska and Wyoming southward to the Rio Grande the week was abnormally cool and unfavorable for the advancement of crops. On the Pacific coast crops made satisfactory growth, although drying winds proved detrimental to late grain in portions of California. In the States of the Lower Missouri and Upper Mississippi valleys corn experienced less favorable conditions than in the previous week, owing to the prevalence of low temperatures and excessive moisture, but in the Ohio Valley and Middle Atlantic States the conditions were highly favorable for germination and growth, as well as for planting. In Minnesota and the Dakotas planting was nearly finished, and in Wisconsin and Michigan it was well advanced. More numerous reports of injury to winter wheat by the Hessian fly were received than in the previous week, especially in the States of the Ohio and Central Mississippi valleys, but otherwise the crop made satisfactory advancement, although too rank growth was reported from portions of Nebraska and Texas. Over the northern portions of the spring-wheat region rain was generally needed, especially for late-sown spring wheat, but over the southern portion the crop was doing well. Oats made slow growth in the valleys of the Upper Missouri and the Red River of the North, and although rains improved the condition of the crop in the Ohio Valley and Middle Atlantic States, unfavorable reports continued from these districts. Generally throughout the Gulf States, Lower Missouri, and Central Mississippi valleys the outlook continued satisfactory. Cotton made slow growth, especially over the central and western portions of the cotton belt, the nights being too cool. In Oklahoma and Texas there had been too much rain, while rain was needed for late-planted cotton in portions of Alabama and Georgia. In Texas fields were grassy, but elsewhere cultivation made favorable progress. Transplanting of tobacco was begun in Kentucky, Ohio, and Maryland, conditions being very favorable for this work in Virginia and North Carolina. The supply of plants continued abundant.

*May 28.*—With general absence of rain, or only light showers, in the Dakotas and Minnesota, the previously existing drought conditions in these States became more serious. Rain was also needed over a large part of the lake region, Ohio Valley, and portions of the Middle Atlantic and Central Gulf States. The temperature conditions in the districts east of the Rocky Mountains were generally favorable, although complaints of cool nights continued from the East Gulf and South Atlantic States. On the North Pacific coast the week was abnormally cool and unfavorable. The general condition of corn in the principal corn States was rather better than in the previous week, although it was somewhat backward in Missouri, Kansas, and Arkansas. The late planted over the northern portion of the lake region and in Minnesota and South Dakota germinated poorly on account of lack of moisture. Cut worms were reported as damaging corn in the Middle and South Atlantic and Central Gulf States and in Kansas. In Texas the condition of the crop was irregular and below the average, but was improving. Winter wheat was ripening as far north as North Carolina, Tennessee, Arkansas, and Oklahoma, and harvesting was begun in the southern portions of the Gulf States. In Missouri, Kansas, and Kentucky the outlook continued promising, notwithstanding injury by fly. Wheat was heading short in the Middle Atlantic States. In Indiana, Ohio, Michigan, and Wisconsin, where wheat was very poor, there was no material change in its condition, except further deterioration in Ohio. Harvesting under favorable conditions continued in California. In Washington and Oregon rust was reported in some localities. The northern and western portions of the spring-wheat region experienced very unfavorable conditions, the abnormally high temperatures with absence of rain proving very detrimental to spring wheat, but over the southeastern portion the crop made satisfactory progress. Oat harvest was general in the Southern States and was yielding well. In the Middle Atlantic States, Ohio Valley, and Tennessee the crop suffered much from drought, and the outlook was not favorable. From the Upper Mississippi and Lower Missouri valleys more favorable reports were received. While cotton continued backward, there was quite a general improvement in its condition, especially over the eastern and western portions of the cotton belt, the least favorable reports coming from the central portion. All sections, however, continued to report the unfavorable effects of cool nights.

*June 4.*—The drought conditions existing at the close of the previous week over a large part of the lake region and Ohio Valley and portions of the Middle Atlantic and Central Gulf States were generally relieved by abundant rains, and the severe drought in the Dakotas and Minnesota was partially broken, but the northern and western portions of Wisconsin and Minnesota continued to suffer seriously, and more rain was needed over portions of the Middle and South Atlantic States. Unusually heavy rains fell over a large part of the Central and West Gulf States, in the Lower Ohio Valley, portions of Alabama, Mississippi, Louisiana, and Texas receiving from 2 to 14 inches. These excessive rains retarded farm work and caused damage by washing out crops. The temperature conditions of the week, as a whole, were favorable. Generally the reports indicated that corn had made satisfactory advancement, but the crop continued somewhat late in some sections, and cutworms were causing damage in Indiana, South Dakota, Kansas, Texas, South Carolina, and Maryland. In the States of the central valleys, excepting Ohio, the crop was generally well cultivated. Winter-wheat harvest was begun as far north as southern Kansas, and wheat was ripening in the southern portions of Missouri and Illinois. The heavy rains in Texas seriously interfered with harvesting and injured wheat in shock. The crop made satisfactory progress in the States of the Central Mississippi and Lower Missouri valleys, but reports of injury by fly continued from the Ohio Valley, and while short straw was generally reported from the Middle Atlantic States, the heads were filling well, except in Pennsylvania. In California harvesting continued with large yields, and the crop had made favorable progress in Washington and Oregon, although rust was reported from portions of Washington. Rains improved the condition of spring wheat in the Dakotas and Minnesota, but the general condition of the crop in these States was unpromising, some fields in North Dakota being plowed up for other crops. More rain was needed in portions of Minnesota and South Dakota. Very favorable reports respecting spring wheat were received from Washington and Oregon. In South Dakota, Minnesota, and southwestern Missouri oats suffered from drought, while too rank growth was reported from Iowa and Nebraska. The reports respecting oats, however, were more favorable than in the previous week. Harvesting continued in the Southern States and as far north as North Carolina. Rains of this week somewhat improved the outlook for hay in the Ohio Valley, but the crop in these States, as well as in the Middle Atlantic coast districts, Wisconsin, Minnesota, northern Iowa, South Dakota, and southern Missouri, promised to be short. In Nebraska, Kansas, and Colorado, and on the Pacific coast haying was progressing under favorable conditions. Over the central and eastern portions of the cotton belt there was a general improvement in cotton, although slow growth was reported from Georgia and South Carolina, where rain was needed. In Texas where planting was not yet completed the crop suffered much from excessive rains, was much in need of cultivation, and was being damaged by insects. The week was exceptionally favorable for transplanting tobacco in the Ohio Valley and Middle Atlantic States, the bulk of the crop in Kentucky having been set. The general fruit outlook, except for apples, which were dropping extensively, continued promising.

*June 11.*—Heavy rains in the central and east Gulf States, including portions of Kentucky, Tennessee, and southern Illinois, and central and northern Indiana, retarded cultivation, and in some sections caused injury to crops, while drought conditions continued in the Dakotas, northern Minnesota, eastern Montana, and generally throughout the central and northern Rocky Mountain districts. Rain was much needed over a large part of the Middle Atlantic States. In the States of the central valleys the conditions were generally very favorable to the advancement of crops, except where excessive rains had delayed cultivation. The general absence of rain, or only light showers, in Texas proved especially beneficial and afforded much needed opportunity for cultivation. On the Pacific coast the weather conditions were generally favorable, except in portions of Washington and Oregon, where rain was needed. The high average temperature, with generally sufficient moisture, in the great corn States of the central valleys was decidedly favorable to corn, which made rapid growth, although it needed cultivation in some sections. In Maryland, Virginia, and portions of North Carolina and Texas corn needed rain, while it suffered from excessive rains in the central Gulf States. In the Dakotas, Minnesota, and Wisconsin the outlook was unfavorable as a result of the protracted drought, although encouraging reports were received from portions of South Dakota and Wisconsin. Winter-wheat harvest was now in progress in central Kansas, southern Missouri, and Virginia. Except some lodging in Kentucky and Tennessee, and injury from rain in Arkansas, the reports generally indicated that the crop had made satisfactory advancement during the week, although further deterioration was reported from Michigan. On the Pacific coast the reports respecting wheat were generally favorable, but some fears were entertained that the frost of the 9th had caused injury in portions of Washington. Harvesting continued in California and had begun in Oregon. The northern portion of the spring-wheat region received only scattered light showers during the week, and wheat in that section was in very poor condition. In North Dakota the crop was thin and very weedy and a considerable portion in that State and also in Minnesota was being plowed up for other crops. In South Dakota and southern Minnesota the outlook was less discouraging, although a poor crop was promised. The prospect for a good oat crop continued flattering except in the drought area of the Northwest. Short straw, however, was reported from the Middle Atlantic States, and local storms caused injury to oats of rank growth in Iowa. The hay crop was further improved in the principal hay States, but the yield as a whole promised to be light. As a result of fair weather in Texas, much of the State receiving no precipitation, cultivation was vigorously pushed and there was a decided improvement in the condition of cotton. Several days of fair weather were still needed, however, to put the crop in a proper state of cultivation in some parts of Texas. While there was a general complaint of lice in cotton in the central and eastern portions of the cotton belt, the crop made substantial progress, although in quite general need of cultivation. The least favorable reports were received from Louisiana, where cotton had made but slow growth and was turning yellow. The bulk of the tobacco crop had been transplanted in the Ohio Valley and Middle Atlantic States, and a large part of the crop in New England had been set, an excellent stand being reported from the States of the Ohio Valley.

*June 18.*—The protracted drought over the northern portion of the spring-wheat region continued, and rain was needed in portions of New England and Texas, and generally throughout the Rocky Mountain districts. Abundant rains thoroughly relieved the drought conditions in the Middle Atlantic States, while excessively heavy precipitation interrupted farm work and caused damage to crops in the South Atlantic and eastern Gulf States, lower Ohio, and central and lower Mississippi valleys. The week was unseasonably cool in the lower Missouri and upper Mississippi valleys and upper lake region, light frosts occurring over the eastern portion of the upper Michigan peninsula. On the Pacific coast the week was generally favorable, although light showers damaged grain and fruit to some extent in northern California, and abnormal heat in Washington proved unfavorable. While the week was rather cool in the great corn States of the central valleys, corn made very favorable progress, especially in the States of the Missouri Valley, where the crop was growing rapidly and was well cultivated, except in portions of Missouri. The crop needed cultivation in the lower Ohio Valley, western Tennessee, Arkansas, and generally throughout the east Gulf States. In the Middle and South Atlantic States corn made decided advancement, but it needed rain in portions of Texas and Louisiana. Heavy rains in the central Mississippi Valley retarded the harvesting of winter wheat, especially in portions of Missouri, Arkansas, and western Tennessee, and in the two last-named States some damage was done to wheat in shock. Harvesting continued under generally favorable conditions in Oklahoma and Kansas. Very unfavorable reports respecting spring wheat continued from the northern portion of the spring-wheat region, where no rain, or only very light showers, fell during the week. In North Dakota much of the early sowing was damaged beyond recovery, and in Minnesota it was thin and heading short, with small heads. In South Dakota a general improvement was expected as a result of late rains, though to what extent was uncertain, as many fields were weedy and some appeared irreparably damaged. In Washington and Oregon spring wheat experienced improvement. The general condition of oats continued promising, except where shortened by drought in Wisconsin, Minnesota, the Dakotas, and Nebraska. Some damage had been caused to oats in shock by excessive rains in the South Atlantic and east Gulf

States. Further improvement was reported in hay from some of the principal hay States, especially in late meadows. A fair yield was promised in Indiana and Illinois; haying was now in progress in the more northerly sections. In Arkansas and eastward of the Mississippi River, except in portions of the Carolinas, cotton suffered seriously in consequence of excessive rains, lack of cultivation, and lice. In Texas continued dry weather, except scattered showers, were exceptionally favorable for cleaning the crop, which, however, was of irregular size over the southern portion of the State, and notwithstanding the favorable weather for cultivation many fields were still foul. In Louisiana the weather conditions were very favorable for cultivating cotton. The week was exceptionally favorable for transplanting tobacco and for that already set. Nearly all reports indicated a promising outlook for this crop, although it was badly in need of cultivation in Tennessee.

*June 25.*—The South Atlantic and the central and eastern portions of the Gulf States, including portions of the central Mississippi and lower Ohio valleys, suffered much from heavy rains, while the severe drought over the northern portion of the spring-wheat region continued unbroken, only light showers having fallen over limited areas. In the States of the lower Missouri Valley and on the Middle Atlantic coast the weather conditions were highly favorable, and generally favorable conditions prevailed on the Pacific coast, except in the upper Sacramento Valley, where rains caused some damage. Corn made favorable progress in the great corn States of the central valleys and was in a good state of cultivation, except in portions of the central Mississippi and Ohio valleys, where many fields were weedy. In the southern States east of the Mississippi River corn suffered seriously from excessive rains and was badly in need of cultivation. In Oklahoma, Kansas, Nebraska, and portions of Missouri winter-wheat harvest continued under favorable conditions, but in the central Mississippi and Ohio valleys it was interrupted by heavy rains, which also caused much damage to wheat in shock. Harvesting made good progress under favorable weather conditions in the Middle Atlantic States. Throughout the South Atlantic and east Gulf States there was also much complaint of injury to wheat in shock. The outlook for wheat on the Pacific coast continued promising, except in the Willamette Valley, where a poor crop was indicated. Spring wheat suffered further deterioration over the northern portion of the spring-wheat region as a result of the continued unfavorable weather conditions, no rain, or only light showers over limited areas, having fallen. In North Dakota the early sown was reported as practically dead. In both North Dakota and Minnesota fields were being plowed up for other crops, and, while the outlook in South Dakota was more promising, not more than half an average crop was expected. In Iowa the crop was doing fairly well. Except in the Dakotas, Minnesota, and northern Wisconsin, the reports respecting oats continued favorable, a decided improvement being reported from the Ohio Valley. Further damage was reported to oats in shock in the east Gulf States. A very general improvement in the condition of hay was indicated, except in Wisconsin, Minnesota, North Dakota, New York, and New England, the crop being almost a failure in Minnesota and North Dakota and promising about one-half an average yield in New York. Rains on the North Pacific coast proved very detrimental to the hay crop. Except in Texas and Oklahoma cotton experienced very unfavorable weather conditions, and was generally very grassy, rust and lice being extensively reported throughout the central and eastern portion of the cotton belt. Too rapid growth was also reported from the central portions of the belt, while growth was checked by low temperatures in North Carolina. Some fields in bottom lands in Mississippi and Tennessee were abandoned. In Texas the bulk of the crop was now clean and a general improvement was reported, except in some portions of the eastern portions of the State, where fields were abandoned on account of grass. Boll weevil was causing damage in southern Texas. In the uplands of Tennessee and portions of eastern South Carolina cotton was generally in good condition.

*July 2.*—Heavy rains fell over a large part of the South Atlantic, central, and east Gulf States, Tennessee, and the Ohio Valley, which districts suffered much from excessive moisture in the previous week. Very favorable weather conditions prevailed in the Middle Atlantic States and generally in New England and the lake region. The severe drought in the valley of the Red River of the North was partially relieved by from 1 to more than 2 inches of rain over northern Minnesota, and light to heavy showers in North Dakota. Rain was much needed throughout the Rocky Mountain region and plateau districts. The week was marked by exceptionally high temperatures over the middle Rocky Mountain slope and upper Missouri Valley. Corn suffered injury from heavy rains in portions of Indiana, Illinois, Missouri, and Kentucky, and generally in the east Gulf States, but on the whole made very favorable progress, especially in the great corn States. In Iowa and Nebraska the crop was in fine condition, having received its final cultivation in Iowa. In portions of

Kansas, Oklahoma, and Texas corn suffered from drought and was in need of rain over portions of the Middle Atlantic States. In the Ohio and central Mississippi valleys, as in the previous week, winter-wheat harvest had been interfered with by heavy rains and reports of damage to grain in shock continued. In the Middle Atlantic States harvesting continued under favorable conditions and was practically finished as far north as Maryland. In South Dakota the crop was very uneven and continued to suffer for rain. In the Southern States oats in shock sustained much damage as a result of heavy rains which also injured the unharvested crop in the central Mississippi and Ohio valleys; elsewhere, except in the drought region of the Northwest, reports respecting oats were generally favorable. Further improvement in the condition of hay was reported from the Ohio and central Mississippi valleys, where, however, in some sections the weather conditions were unfavorable for haying. Over nearly the whole of the central and eastern portions of the cotton belt the weather was very unfavorable to cotton, which was largely overrun with grass and weeds, some fields in Mississippi and South Carolina having been abandoned. In North Carolina, Florida, and on uplands in Tennessee the condition of the crop was more favorable. In Texas it was generally clean and making good growth, although very irregular, and was needing rain over the central and western part of the State. Tobacco needed rain in Maryland, but the general condition of the crop in the other tobacco States was very promising except in western Kentucky and portions of Tennessee, where it was damaged by heavy rains. In New England, New York, Pennsylvania, Wisconsin, and Minnesota the reports respecting apples were very favorable, but dropping continued to be extensively reported in the States of the central valleys and in portions of the lake region. In Oregon the outlook for a large crop of apples of superior quality was promising, and very favorable reports were received from California, Colorado, and New Mexico.

*July 9.*—As a whole this week was highly favorable in the districts east of the Rocky Mountains. The drought-stricken regions of the Northwest received bountiful rain, and the central and east Gulf States, which suffered much from excessive rains of previous weeks, for the most part experienced very favorable weather. Drought continued in the Rocky Mountain regions, and rain would have been beneficial in portions of Missouri, Kansas, and Texas, in Florida, and on the Atlantic coast northward of the Carolinas. The week was marked by exceptionally high temperatures in the lower Missouri Valley and on the Atlantic coast from southern New England to Florida. Corn made rapid growth, and generally was in fine condition in the States of the central valleys, although suffering for rain in portions of Missouri, Nebraska, Kansas, Oklahoma, and Texas. In the east Gulf States and portions of Tennessee much damage was done on lowlands by rains of previous weeks. The weather conditions in the central valleys were more favorable for harvesting, and winter-wheat harvest was nearing completion in the more northerly districts. Thrashing was in general progress and yields better than expected were reported from Kentucky, Tennessee, and Illinois. The general and abundant rains in the Dakotas and Minnesota improved the outlook for late spring wheat, especially in Minnesota and South Dakota. In North Dakota most of the crop had been too badly damaged to be revived. Except in New England, Minnesota, and the Dakotas reports respecting oats continued favorable and the crop was now ripening in the more northerly districts. In the Dakotas and Minnesota the rains of this week were of much benefit. The weather was generally favorable for securing hay, except over portions of the upper Lake region and upper Mississippi Valley, where rains were detrimental. The week was generally very favorable for giving cotton much needed cultivation, and an improvement in the condition of this crop was reported from the greater part of the cotton belt, being most decided in the eastern portions. Too rapid growth was, however, reported from the central districts, and some lowland fields were abandoned in Tennessee and Louisiana. In Texas the crop made rapid growth, except in the western portion, where rain was needed, and was generally well cultivated, except in some parts of eastern Texas. The general condition of the tobacco crop was favorable, but rains would have been beneficial in Maryland and portions of Virginia. An improvement was reported from Kentucky where the crop had suffered from excessive rains of previous weeks. Cutting and curing were in progress in the Carolinas. The outlook for apples continued promising in New York and Pennsylvania, and they were not falling so badly as previously reported in Ohio, but generally throughout the Ohio and Central Mississippi Valleys, embracing an important part of the apple region, complaints of dropping continued a marked feature of the reports.

*July 16.*—Notwithstanding the excessively heavy rains on the west Gulf coast and in portions of the central Missouri Valley, and the prevalence of drought to a greater or less extent in the Middle and South Atlantic States and over portions of Missouri, Kansas, and Oklahoma, the week was generally favorable in the districts east of the

Rocky Mountains. Throughout the Rocky Mountain and plateau regions there was general scarcity of water, especially over the southern districts. The condition of corn in Kansas and Nebraska was less favorable than in the previous week, and the crop was suffering for rain in portions of Missouri, southern Ohio, West Virginia, Maryland, Virginia, and North Carolina. In Indiana, Illinois, and Iowa corn made very favorable progress, and was improved in Kentucky, Tennessee, and Pennsylvania. Harvesting of winter wheat was about completed, except in the more northerly districts, the weather conditions being favorable for this work in the districts east of the Mississippi River, except in portions of New York, where it was interrupted by rains. Harvesting was well advanced on the Pacific coast. Further improvement in the condition of spring wheat was reported from Minnesota and South Dakota, and while no decided improvement was reported from North Dakota, the weather conditions in that State were propitious. In Minnesota the crop suffered some damage from local storms. Fair to good yields were expected in the extreme southeastern counties of South Dakota. Oat harvest was in progress in the States of the central valleys and a very fine crop was being secured in good condition. Wet weather interrupted haying in northern New England, but elsewhere the hay harvest made satisfactory progress and was nearly completed in the States of the central valleys. Rains caused damage to hay in Michigan, Louisiana, and Texas. A general improvement in the condition of cotton was reported, except in Florida and Louisiana, but the plant was small and fruiting slowly in the central and eastern districts of the cotton belt where some fields were still grassy. In Texas the crop made good growth, but was very uneven, and the early planted was fruiting well, except in scattered localities. In Virginia, Tennessee, and the Carolinas the tobacco was suffering from drought, and was "buttoning" low in the two first-named States. In the Ohio Valley, New England, and over the northern portion of the Middle Atlantic States tobacco made favorable progress. The continued dropping of apples in New England, the central valleys, and upper Lake region materially reduced the prospects for this crop in those districts, but the outlook continued encouraging in New York and portions of Pennsylvania, Ohio, and Indiana.

*July 23.*—Rain was very generally needed in the Atlantic coast districts north of Florida, the drought being quite severe in the Carolinas, New Jersey, and portions of New England, while too much rain fell over portions of the central valleys, northern Texas, the central Gulf States, and northern Florida. Very favorable temperature conditions prevailed during the week, except in the Middle Atlantic States, upper Missouri Valley, and over portions of Washington and Oregon, where unusually high temperatures were detrimental to crops. While the condition of corn in Kansas and Nebraska improved, the reports indicated that much of the early crop in portions of these States had been seriously injured by drought. In the other great corn States of the central valleys the crop made rapid growth under highly favorable conditions. Throughout the Atlantic coast districts corn was generally in need of rain. Rains interfered with thrashing and the completion of the winter wheat harvest where unfinished over the more northerly sections of the central valleys, but the conditions were highly favorable for harvesting in the Middle Atlantic States and on the north Pacific coast. In the central valleys and Lake region harvesting and thrashing were not only delayed, but rain caused injury to grain in shock in portions of these districts. Spring-wheat harvest was in general progress in South Dakota and portions of Minnesota and had begun in North Dakota. In South Dakota and Minnesota the crop made advancement although excessive rains and local hail storms caused some damage in southeastern South Dakota. In North Dakota the high temperatures proved injurious, and in South Dakota and Washington the crop suffered from hot winds. Oat harvest was nearing completion in the central valleys where the crop suffered to some extent from rain. Haying was interrupted, and the crop damaged to some extent by rains in the central valleys. In New York and New England haying was practically finished, the yield in New York being better than was expected. Generally there had been some further improvement in the condition of cotton, but the crop was suffering from drought in the Carolinas and from too much rain in portions of the central belt and in portions of Texas. In the last-named State it generally made rapid growth, being excellent in places and poor in others. Shedding was reported from the greater part of the cotton belt and rust from the eastern districts. In the Carolinas and Virginia tobacco suffered for rain, but late rains had improved the crop in Maryland. In the other tobacco sections the condition of the crop was promising.

*July 30.*—The drought prevailing at the close of the previous week in the Atlantic coast districts was wholly relieved by local rains, except in southern Florida, and this week, as a whole, in the districts east of the Rocky Mountains was one of highly favorable temperature conditions with generally abundant moisture. On the Pacific coast the conditions were also generally favorable, although the eastern portions of Oregon and Washington experienced very high temperatures. The corn crop made splendid progress. All reports from the States of the central valleys indicated that it made rapid growth and that the early planted was nearing maturity over the southern portions of the principal corn States. Some early corn in the Carolinas and Virginia had been permanently injured by drought, but late corn in these States was progressing favorably. Winter-wheat harvest was practically completed, except where delayed by rains in some districts over the northern portion of the winter-wheat region. Thrashing was quite generally delayed in the central valleys as the result of rain, and injury to wheat in shock was quite extensively reported. Harvesting continued on the Pacific coast. Spring-wheat harvest was now general in the northern portion of the Red River Valley and was progressing favorably in the southern portion of the spring-wheat region. The dry warm weather rapidly matured the crop in North Dakota, where owing to short straw much had to be mowed. In southern Minnesota a large part of the crop was in shock, and in the northern portion of the State the wheat heads were reported as well filled. In South Dakota fair to good yields were indicated in the extreme southeastern counties, the crop being poor to fair elsewhere but generally of good quality. Rains caused some further delay in oat harvest, which, however, was nearly finished in the more northerly sections. Some damage to oats in shock was reported from West Virginia, Indiana, and Illinois. Over the eastern and western portion of the cotton region there was a material improvement in the condition of cotton, but in the central districts it suffered further from continued rains. In Texas the crop had been generally laid by in good condition and was promising in many localities, while complaints of too rank growth, light bolls, weevil, and boll worms were reported. Some early tobacco suffered permanent injury from drought in Virginia and North Carolina, but elsewhere reports indicated that the crop was in promising condition, having been greatly benefited by rains during the preceding week. The outlook for apples in New York and Pennsylvania continued promising, and improved prospects were reported from portions of Illinois, Missouri, and Iowa, while dropping was still quite extensively reported from a number of important apple States.

*August 6.*—This week was very hot in the States of the upper Mississippi and Missouri valleys, and while there was a general lack of rainfall over a large part of the country east of the Rocky Mountains, excessively heavy rains fell in portions of the Gulf States and over portions of the central Ohio and upper Missouri valleys, and the valley of the Red River of the North. Rain was generally needed in the central Mississippi and lower Missouri valleys, and in the Atlantic coast States from the Carolinas northward. Corn, more particularly the late planting in the States of the central Mississippi and Missouri valleys, was in need of rain, but the early plantings in these sections was generally beyond serious injury from drought. In the Lake region and Ohio Valley and generally in the Atlantic coast districts the crop made good progress, but was beginning to need rain in the Middle Atlantic States. The general absence of rain was very favorable to thrashing winter wheat, which was nearing completion in nearly all districts. Spring-wheat harvest was nearly finished over the southern portion of the spring-wheat region where some thrashing had been done, and thrashing was well advanced in the northern portion. Portions of the Dakotas and Minnesota received very heavy rains during the week. In South Dakota late spring wheat experienced very trying temperature conditions, and a larger part of the crop than was anticipated was being cut for fodder. The week was favorable for completion of the oat harvest and thrashing. Over the northern portion of the central and western districts of the cotton belt the condition of cotton improved and while an improvement was reported from the Carolinas, its general condition in Georgia, Florida, and Louisiana was less promising, complaints of rust, shedding, and premature opening being numerous. In Texas cotton was from two to three weeks late, its condition in the northern portion being promising, while complaints of rank growth, shedding, and the ravages of insects were received from the southern part of the State. The tobacco crop made favorable advancement and its condition was generally promising, although it needed rain in Virginia. Some cutting was done in Ohio. The persistent dropping of apples materially reduced the prospects of this crop in many important States, although the outlook in Iowa was somewhat improved. Reports continued very favorable, however, from New York and Pennsylvania, and a good crop was promised in Minnesota. Plowing for fall seeding had made very favorable progress, except in Missouri, where the ground was too dry.

*August 13.*—This week was intensely hot from the Missouri Valley eastward to the Atlantic coast, including the South Atlantic coast States, with practically no rain over a large part of this area, although heavy rains occurred over the Missouri and upper Mississippi valleys and the valley of the Red River of the North and the lake region. It was unseasonably cool in the plateau and Pacific coast regions, except on the immediate northern coast, frosts occurring on the 8th and 9th in Nevada. In the west Gulf States the temperature averaged below normal, and very heavy rains fell, more than 18 inches being reported from Beeville, Tex. Owing to the extreme conditions of heat and dryness, and excessive rains in certain districts, the week, as a whole, was unfavorable to agricultural interests in the districts east of the Rocky Mountains, but on the Pacific coast it was very favorable. In portions of Missouri and Kansas corn, more especially the late planted, was materially injured, and the crop sustained damage in Nebraska, Iowa, and Illinois. In Iowa the bulk of the crop was unharmed and well advanced toward maturity, and in Illinois a large yield was still promised. The outlook in Indiana and western Ohio also continued very promising, but in central and southeastern Ohio and throughout the Middle Atlantic States corn sustained serious injury as a result of drought and the intense heat. In the principal States of the corn belt the reports indicated that the bulk of the crop would be safe from frost by September 1 to 10, and that the late crop would be matured one to two weeks later. Heavy rains in the principal spring wheat States prevented the completion of the spring wheat harvest and caused injury to the overripe standing grain, as well as to that in shock and stack. Over portions of the central belt cotton improved slightly, although rust and shedding were generally reported, and the crop needed rain in portions of Mississippi, while suffering from excessive moisture and lack of cultivation in parts of Louisiana. In the Carolinas, Georgia, and Arkansas the condition of cotton deteriorated materially, premature opening being extensively reported from the Carolinas. In northern Texas cotton made favorable progress, but elsewhere in that State it needed dry weather and was making too rank growth. Some picking had been done over the southeastern portion of the cotton belt, and while cotton was opening in southwestern Texas, picking was not general in that State as yet. In the Middle Atlantic States, including North Carolina and Ohio and portions of Kentucky, tobacco suffered much from drought and heat, but in the last-mentioned State the general condition of the crop was promising. Some cutting had been done as far north as Maryland and Ohio. Very little plowing for fall seeding was done during the week.

*August 20.*—This was the third week of excessive heat over the greater part of the country east of the Rocky Mountains, and while intensely warm from the Rocky Mountain slope and upper Missouri Valley eastward to the Atlantic coast, a large part of the central valleys and portions of the Middle Atlantic States and New England were favored with abundant rains. Western Nebraska, Kansas, southern Missouri, and an area extending from Oklahoma eastward over Arkansas to central Tennessee, as well as portions of the Middle Atlantic and east Gulf States, suffered more or less seriously from drought. Rain was also needed in Washington and Oregon, and while continued cool weather in California was favorable to crops, it retarded fruit drying. In western Nebraska, Kansas, central and southern Missouri, and southern Illinois corn suffered much from drought and intense heat, but in other portions of the principal corn belt, although injured to some extent by storms, the crop experienced very favorable conditions and made rapid progress toward maturity. While the bulk of the crop in the Southern States was made, late corn had been greatly shortened over a great part of this section, as well as portions of the Middle Atlantic States, by the intense heat and lack of moisture during the two preceding weeks. Spring wheat harvest was completed in Minnesota, but frequent rains in the Dakotas prevented its completion in those States and caused injury to grain in shock and stack and the overripe, unharvested grain was shelling badly. In Washington and Oregon the weather conditions were favorable for harvesting. Considerable injury to unthrashed oats was reported from the States of the upper Mississippi and upper Missouri valleys as a result of heavy rains. A slight improvement in the condition of cotton was reported from portions of Mississippi and Louisiana, where, however, complaints of insects, shedding, and slow growth continued. Over the eastern portions of the cotton belt the reports were generally unfavorable, indicating premature opening, shedding, and prevalence of rust. In Tennessee, Arkansas, Oklahoma, and Missouri the reports were also unfavorable, rust and premature opening being general. In Texas the crop as a whole was improved, but was shedding and had sustained damage from rust and insects in many localities. Tobacco was needing rain in portions of Kentucky, Tennessee, and the Middle Atlantic States, but elsewhere the crop made good progress, cutting being general. In New England and New York the prospect for apples continued promising, but in the important apple States of the central valleys the reports generally indicated further deterioration, although the outlook in some sections was encouraging. More favorable progress was made with plowing for fall seeding than in the previous week over the northern districts, but this work was but little advanced in portions of the Middle Atlantic States and lower Missouri Valley.

*August 27.*—The week ending August 27 was the fourth week of excessive heat in the districts east of the Rocky Mountains, and while it was dry over the greater part of the Southern States and in portions of New England and the Ohio Valley, there were in these districts good rains over local areas and very general and abundant rains over the northern portions of the central valleys, southern half of the upper lake region, and in the Middle Atlantic States. The temperature conditions of the week, as in the preceding weeks of August, were highly favorable for the rapid development of corn, and a large part of the early crop was now fully matured, some having been cut as far north as Iowa and Illinois. The abundant rains which fell in Nebraska, Kansas, and Missouri improved the condition of corn, but much in the two last-named States had been permanently injured, while the crop in southern Illinois and western Kentucky continued to suffer from drought. As a whole, the week was very favorable for corn over the greater portion of the principal corn States, more particularly the central and northern districts, but over the northern portions of the Gulf and South Atlantic States it was unfavorable. Heavy rains in the spring-wheat region retarded thrashing and prevented the completion of harvest in North Dakota, in which State, as well as in Minnesota and portions of Nebraska, stacked wheat sustained damage. Rains also delayed thrashing in Montana and Washington. Except in Alabama, where an improvement in the condition of cotton was reported, the general condition of this crop over the central and eastern portions of the cotton belt further deteriorated, rust, shedding, and premature opening being generally reported, while the bollworm proved destructive in the central and western portions. In Texas cotton was generally improved in the southern portion, but in some localities in the northern portion it was injured by hot winds. Picking was in general progress over the central and southern portions of the belt. In western Kentucky, the Carolinas, and portions of Virginia and Maryland tobacco suffered much from drought, but in the two last-named States rains materially improved its condition. In the other tobacco States the crop made very favorable progress, although sustaining damage from hail in Wisconsin. The reports continued to indicate a good apple crop in New England, New York, and portions of Pennsylvania, and while favorable reports were received from localities in the principle apple States of the central valleys, the persistent dropping that had been so prominent a feature in the reports during the early part of the season, with the excessive heat in August, and in some sections high winds, materially reduced the prospects for this crop. Over the central and northern districts the condition of the soil was highly favorable for plowing for fall seeding, which work was unusually well advanced in those sections, but in the Southern States the conditions were not favorable.

*September 3.*—Over the greater portion of the country the weather conditions were highly favorable for maturing crops, although droughty conditions continued in portions of the Gulf States, Illinois, and Missouri, in Colorado, and in the arid regions of the Southwest. Rain was also needed in New England and the Middle Atlantic States. In California continued cloudy weather was unfavorable for fruit drying. Damaging frosts occurred in the northern plateau region and light frost in New Mexico. Corn was ripening rapidly and cutting was becoming general in all except the more northerly sections. In the principal corn States much of the early crop was now beyond possible injury from frost. Late corn showed no improvement in central Kansas, was a failure in portions of Missouri and Arkansas, and was injured by drought in some localities in Kentucky. Elsewhere the reports indicated an excellent crop of generally good quality. Thrashing of spring wheat progressed rapidly under favorable conditions. In North Dakota high winds, with absence of rain, dried the grain sufficiently for thrashing, although the bulk of it was considerably damaged by having sprouted and become musty and moldy in both shock and stack. The rain-damaged stacks in South Dakota were considerably improved by dry, warm winds. No general improvement in the condition of cotton was reported. Premature opening had been checked in the Carolinas, shedding had ceased in South Carolina, and the late crop in that State was again blooming and fruiting. Complaints of rust, shedding, premature opening, and injury from bollworms still continued from the central portions of the cotton belt. In Texas cotton was from two to four weeks late, except in scattered localities of the northeast portion. Reports indicated that in many localities of northern Texas there would be an average crop, but elsewhere it promised to be generally below, especially in the southern portion, where in a few places cotton was almost a failure, while hot winds, Mexican weevil, and bollworms damaged the crop in many localities. Cotton picking was general in all sections, except in Missouri and Tennessee. Tobacco cutting and housing was in full progress, being nearly completed in Ohio and Indiana. The crop suffered from injury from hot weather in the first-named State, and late tobacco, though improving, was damaged by worms in Maryland and was scalded and poor in North Carolina. Elsewhere reports were favorable. While the reports concerning apples indicated a good crop in New England, New York, Minnesota, California, and portions of Pennsylvania, Illinois, and Kansas, the prospects were not so favorable in other important apple-growing States, where the fruit was still dropping considerably. Fall plowing was progressing satisfactorily in all sections, except in a few localities where rain was needed to place the soil in condition. Some seeding was done in Kansas, Nebraska, Missouri, and Michigan.

*September 10.*—Hot and dry weather was a marked feature of the reports from the greater number of the States east of the Rocky Mountain slope, excepting the northwest and the upper peninsula of Michigan, where rains retarded work and caused some damage to outstanding crops. Beneficial rains occurred in Florida, New Mexico, and portions of Alabama, Louisiana, Illinois, Ohio, New York, and Pennsylvania. Droughty conditions, however, prevailed in New England, the Atlantic coast States, the central valleys, northern portion of the Gulf States, and the southern portion of the plateau region. Generally favorable weather conditions prevailed on the Pacific coast, although rains caused some delay to farm work in Oregon and slightly damaged late fruit in California. The hot, dry weather rapidly matured corn. Cutting was in progress in all sections, and an excellent crop was insured in the principal corn-producing States. Late corn was drying in central Kansas, was seriously injured by drought in portions of Kentucky, and was short in West Virginia, Virginia, portions of Pennsylvania, and the South Atlantic States. In the eastern part of the cotton belt the greater part of the crop was now open, and picking was progressing rapidly, but had been delayed by showers in Florida. Complaints of rust, shedding, and premature opening continued, and some damage from rain resulted to the open staple in Georgia, while the bolls were small and difficult to pick. No serious injury to cotton from the tropical storms of this week was reported from the central section of the cotton belt, but the crop sustained great damage in Texas. In Louisiana the first picking was yielding fairly well, but the prospects for a top crop in that State, as well as in Mississippi and North Carolina, were unfavorable. Slow progress was made in picking in Arkansas and Mississippi, due to hot weather and scarcity of pickers in the first-named State. The greater part of the tobacco crop had been housed, and curing was progressing. Generally good crops were reported from Indiana, Ohio, Pennsylvania, and New York. The late crop was seriously injured by drought in portions of Kentucky, and an inferior yield was indicated in North Carolina. A light yield was also reported from Maryland and Virginia, the crop firing badly and being damaged by worms in the first-named State, and cut tobacco was curing poorly in some sections of Virginia. Droughty conditions retarded and in some sections caused the suspension of plowing for fall seeding in the Middle and South Atlantic States, the Ohio Valley, and Tennessee. In Illinois and Michigan and west of the Mississippi River seeding was in progress, the soil being in fair condition, although too dry in portions of Missouri. Early sown grain in Nebraska was up and looking well.

*September 17.*—The droughty conditions in the Atlantic coast districts were relieved by abundant rains, which, however, came too late to be of material benefit to many crops. Drought continued in the Ohio and central Mississippi valleys and portions of the lower Lake region, while excessive rains retarded work and damaged crops in Nebraska, Minnesota, and the Dakotas. Very general complaint of damage, especially to fruit, by high winds along the path of the tropical storm from the Missouri Valley over the northern districts to the eastward were reported. The continued prevalence of high temperatures was favorable for maturing crops. While light to heavy frosts occurred in the upper Mississippi and upper Missouri valleys on the morning of the 17th, the corn crop in those districts was so far matured as to be practically safe from injury, and although some damage from high winds was reported from Illinois and Indiana, the general conditions of the week were favorable to corn. A large part of the crop had been cut in the States of the central valleys, and some husking had been done. Heavy rains caused damage to cotton in South Carolina, Georgia, Florida, and Alabama. No improvement in the condition of cotton was reported from the central portion of the cotton belt, except in southern Louisiana, where, as a whole, the prospects were somewhat better, while in Texas the tropical storm of the 8th and 9th almost completely destroyed the crop in the southern portion of its path, and damaged it in the central and northern portions. Outside of the storm area cotton made favorable progress in Texas, although insects caused damage in some localities. The reports generally indicated that cotton was opening rapidly and that picking was well advanced and would be completed at a much earlier date than usual. Tobacco cutting, where unfinished, progressed favorably, nearly the whole of the crop having been secured, Pennsylvania, Maryland, Virginia, and Kentucky being the only States in which cutting had not been finished. The prospect for apples was very materially reduced as a result of the damage caused by the high winds of the week, which blew the fruit from the trees in large quantities in nearly all of the principal apple-producing States. In New York the reports indicated that probably more than one-half of the crop had been blown from the trees. The soil was generally in good condition for plowing and seeding, which work had been vigorously pushed, except in the States of the Ohio and Mississippi valleys, where it was too dry. Some of the early sown grain in Kansas, Nebraska, and Oklahoma was already up.

*September 24.*—Heavy rains in central and northern Texas, Oklahoma, Arkansas, the Dakotas, Minnesota, Wisconsin, and upper Michigan interrupted farm work and caused injury to crops, the principal damage in the Dakotas and Minnesota being that done to grain in shock, while in Texas and Oklahoma cotton suffered most. Drought continued in the upper Ohio valley, portions of Missouri, and the Middle Atlantic States, and rains would have proved beneficial in Florida and portions of Alabama. Upon the whole the weather conditions were favorable for farm work and maturing late crops in the States of the Lower Missouri Valley and in the districts east of the Mississippi River. Frosts were quite general in the central and northern Rocky Mountain districts and over the northern portion of the country from the Upper Missouri Valley to the Middle Atlantic States, light frosts occurring as far south as the mountain regions of Tennessee, but only light damage in some localities was reported. The week was favorable for gathering corn in the principal corn States, the bulk of the crop having been gathered in many sections. In the central and eastern districts of the cotton belt cotton picking progressed rapidly, generally under very favorable weather conditions, and was nearly completed in some sections. In central and northern Texas the heavy rains of the latter part of the week caused much damage by beating out open cotton, but in the southern portion picking progressed rapidly under favorable conditions. The weather was highly favorable for curing tobacco, the bulk of which crop was housed. Continued unfavorable reports respecting apples were received, due largely to the high winds of the previous week, which had very materially reduced the prospects for this crop. While the condition of the soil was generally favorable for plowing for fall seeding, this work was delayed in portions of Iowa and Missouri by dry weather, and by excessive rains in Wisconsin and Minnesota. Reports from the States of the Ohio Valley indicated that the acreage of winter wheat would be smaller than usual. In some sections seeding was purposely delayed to avoid the Hessian fly.

*October.*—Rain was generally needed in the South Atlantic and East Gulf States, and over portions of the upper Ohio Valley, Lower Lake region, and Middle Atlantic States in the first days of October, while excessive moisture, due largely to the rains of the previous week, retarded farm work over the region extending from Arkansas and Oklahoma northward to Minnesota and the Dakotas. Killing frosts occurred in Minnesota and the Upper Missouri Valley, and over the northern Rocky Mountain and North Pacific coast regions, the principal damage being that done to late flax in Minnesota and the Dakotas. Very favorable conditions prevailed in the West Gulf States, Central Mississippi and Lower Ohio valleys, and generally on the Pacific coast. East of the Mississippi River the week was very favorable for gathering corn, but in the principal corn States west of the Mississippi this work was interrupted by wet weather, and in portions of Iowa, Missouri, and Kansas some damage was done by heavy rains. Except where interrupted by rains in portions of Arkansas, Oklahoma, and Missouri, cotton picking progressed under exceptionally favorable conditions and was unusually well advanced. In the central and eastern portions of the cotton belt indications were that the bulk of the crop would be gathered by the 10th. Picking was also progressing rapidly in Texas, except on the Lower Brazos bottoms inundated by the rains of the previous week, where the crop was almost a failure. Excellent progress was made with plowing for fall seeding in the States west of the Mississippi River and in portions of the Ohio Valley and Middle Atlantic States, but in the South Atlantic and East Gulf States the ground was too dry.

As a whole October was a very favorable month for farm work, being exceptionally mild to the east of the Rocky Mountains, with ample moisture in most districts. Portions of the Lake region, Ohio Valley, and Middle Atlantic States, however, needed more rain, while heavy rains, principally during the latter part of the month, caused some damage in the Central Gulf States and in the Upper Mississippi and

Missouri valleys. On the North Pacific coast the month was generally favorable, although frequent rains in the latter part of the month retarded work in Oregon. In portions of the Upper Missouri and Mississippi valleys the mild, moist weather proved unfavorable to corn, causing considerable mold and some rotting in localities. With the exception of some damage by fly in portions of Missouri, Illinois, Michigan, and Ohio, the reports respecting fall wheat indicated that the crop was in promising condition. The weather conditions were very favorable for germination and vigorous growth. Cotton picking was interrupted by rains in portions of Arkansas, Louisiana, and Mississippi, and in the last-named State the staple suffered some damage. While picking was practically completed over the eastern portion of the cotton belt, considerable cotton remained to be gathered over the northern portion of the western districts. Under the mild temperature condition the top crop made considerable growth, especially over the eastern districts, but owing to the advanced season it was not expected to mature.

*Average daily temperature departures (degrees Fahrenheit) for season of 1900 from normal based upon observations for many years, by sections.*

| Sections. | From Jan. 1 to Apr. 2, inclusive. | For weeks ending— April— 9. | 16. | 23. | 30. | May— 7. | 14. | 21. | 28. | June— 4. | 11. | 18. | 25. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Middle and South Atlantic States | −1.4 | +0.2 | −3.2 | +6.0 | +3.2 | +0.8 | −0.4 | +4.0 | −2.2 | +0.3 | +0.2 | −0.5 | −4.1 |
| Gulf States | −1.0 | +0.7 | −4.0 | −0.6 | +3.6 | +2.0 | +0.1 | +0.5 | −0.3 | +1.0 | +2.5 | −0.2 | −3.0 |
| Ohio Valley and Tennessee | −1.7 | −0.3 | −8.3 | +4.0 | +5.5 | −0.9 | +0.6 | +4.1 | +1.6 | +0.1 | +1.6 | −1.5 | −3.5 |
| Lake region | −1.3 | +1.9 | −5.0 | +7.9 | +5.6 | −1.1 | +3.0 | +2.1 | +5.0 | 0 | +2.1 | −3.0 | −1.9 |
| Upper Mississippi and Missouri valleys | +1.3 | +4.9 | −5.5 | +3.7 | +8.0 | +2.0 | +6.8 | −0.2 | +5.4 | +3.4 | +3.3 | −2.8 | +0.2 |
| Rocky Mountain region | +4.5 | +1.3 | −4.5 | +1.7 | −1.2 | +3.0 | +6.2 | −1.4 | +1.0 | +3.3 | +3.5 | +1.9 | +5.8 |
| North Pacific coast | +3.8 | −1.3 | +2.3 | +1.3 | −0.7 | +3.3 | +1.0 | +1.0 | −3.3 | 0 | +2.7 | +3.7 | +2.3 |
| California | +2.8 | −1.0 | −0.6 | −1.8 | −2.6 | −0.8 | −0.7 | +3.6 | −0.4 | −0.4 | +3.6 | −1.8 | +1.8 |

| Sections. | For weeks ending— July— 2. | 9. | 16. | 23. | 30. | August— 6. | 13. | 20. | 27. | September— 3. | 10. | 17. | 24. | October— 1. | 8. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Middle and South Atlantic States | +1.8 | +4.1 | −1.2 | +4.4 | +0.1 | −0.4 | +6.6 | +5.6 | +4.8 | +6.1 | +5.7 | +5.5 | +0.6 | +7.0 | + 8.7 |
| Gulf States | +0.3 | +1.3 | −2.2 | −0.5 | −1.5 | +0.3 | +0.6 | +2.2 | +3.4 | +2.3 | +3.5 | +5.1 | +4.0 | +8.6 | + 6.6 |
| Ohio Valley and Tennessee | +0.1 | +3.5 | −2.2 | +2.0 | −1.3 | +2.1 | +6.3 | +4.6 | +6.3 | +6.1 | +7.3 | +6.2 | −0.9 | +9.4 | +11.1 |
| Lake region | −0.3 | +3.0 | −1.5 | +0.8 | −1.0 | +2.1 | +7.5 | +4.2 | +5.8 | +6.9 | +4.9 | +3.8 | −2.2 | +5.8 | +12.1 |
| Upper Mississippi and Missouri valleys | +2.8 | +2.9 | −0.4 | −3.2 | −1.7 | +6.6 | +5.9 | +7.1 | +5.3 | +6.0 | +8.4 | +2.0 | −2.0 | +2.5 | + 8.2 |
| Rocky Mountain region | +3.6 | −1.5 | +1.5 | −1.5 | +0.3 | +1.2 | −1.2 | +1.8 | +0.3 | +3.6 | +5.1 | +1.8 | −0.6 | −3.9 | + 0.4 |
| North Pacific coast | −1.7 | −2.7 | −0.3 | +3.7 | +1.7 | −0.7 | −3.3 | −1.7 | −1.0 | +0.7 | −0.3 | +1.0 | −0.7 | −3.0 | − 4.3 |
| California | 0 | +1.0 | +1.2 | −0.2 | +1.6 | +1.2 | −4.4 | −4.6 | −0.2 | −0.4 | −3.6 | −4.6 | +2.6 | +1.0 | − 3.8 |

*Average daily temperature departures (degrees Fahrenheit) for season of 1900 from normal based upon observations for many years, by stations.*

| Stations. | From Jan. 1 to Apr. 2, inclusive. | For weeks ending— April— 9. | 16. | 23. | 30. | May— 7. | 14. | 21. | 28. | June— 4. | 11. | 18. | 25. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New England: | | | | | | | | | | | | | |
| Eastport, Me | + 0.5 | 0 | + 2 | + 5 | 0 | + 1 | - 6 | - 3 | + 1 | + 6 | - 1 | + 3 | + 2 |
| Portland, Me | - 1.1 | + 2 | - 2 | + 6 | 0 | - 1 | - 7 | - 4 | - 5 | + 4 | 0 | + 1 | + 1 |
| Boston, Mass | + 1.5 | + 3 | - 1 | + 9 | + 1 | + 2 | - 2 | - 1 | - 4 | + 5 | + 1 | + 2 | - 1 |
| Middle Atlantic States: | | | | | | | | | | | | | |
| Albany, N. Y | + 0.2 | + 2 | - 5 | + 9 | + 1 | - 3 | - 6 | + 3 | 0 | + 2 | + 3 | - 1 | + 1 |
| New York City | + 0.3 | + 3 | - 3 | + 8 | + 4 | + 3 | 0 | + 6 | - 1 | + 2 | + 1 | + 1 | + 1 |
| Philadelphia, Pa | + 0.1 | + 2 | - 4 | + 9 | + 5 | + 2 | 0 | + 6 | - 1 | + 1 | + 2 | - 1 | - 2 |
| Washington, D. C | - 0.9 | + 1 | - 7 | + 7 | + 4 | - 1 | 0 | + 6 | - 2 | 0 | 0 | - 5 | - 4 |
| Lynchburg, Va | - 1.7 | + 1 | - 5 | + 5 | + 4 | + 1 | + 1 | + 6 | - 4 | + 1 | 0 | - 2 | - 6 |
| Norfolk, Va | - 0.9 | 0 | - 6 | + 7 | 0 | 0 | + 1 | + 6 | - 6 | + 2 | - 1 | + 1 | - 6 |
| South Atlantic States: | | | | | | | | | | | | | |
| Charlotte, N. C | - 2.5 | 0 | - 5 | + 3 | + 3 | 0 | 0 | + 5 | - 2 | 0 | + 1 | + 1 | - 7 |
| Wilmington, N. C | - 2.2 | - 1 | - 2 | + 7 | + 3 | + 2 | 0 | + 2 | - 3 | 0 | - 1 | 0 | - 7 |
| Charleston, S. C | - 1.5 | 0 | 0 | + 4 | + 3 | + 3 | + 1 | + 3 | - 1 | + 1 | - 1 | 0 | - 5 |
| Augusta, Ga | - 2.9 | - 2 | - 5 | + 5 | + 4 | + 1 | - 1 | + 1 | - 4 | - 2 | 0 | 0 | - 6 |
| Savannah, Ga | - 2.3 | 0 | + 1 | + 3 | + 4 | + 1 | 0 | + 1 | - 2 | - 1 | 0 | 0 | - 5 |
| Jacksonville, Fla | - 2.5 | - 3 | + 2 | + 4 | + 3 | + 1 | - 1 | + 2 | - 1 | - 2 | - 1 | 0 | - 3 |
| Gulf States: | | | | | | | | | | | | | |
| Atlanta, Ga | - 2.6 | + 2 | - 4 | + 3 | + 5 | + 1 | + 2 | + 3 | - 3 | + 1 | + 1 | - 1 | - 7 |
| Mobile, Ala | - 1.7 | - 1 | - 4 | - 1 | + 4 | + 2 | - 1 | + 2 | + 1 | - 1 | 0 | - 3 | - 2 |
| Montgomery, Ala | - 2.9 | 0 | - 2 | + 2 | + 5 | + 1 | - 2 | + 3 | - 2 | + 1 | 0 | - 1 | - 5 |
| Vicksburg, Miss | - 1.2 | + 2 | - 2 | - 1 | + 6 | + 2 | - 1 | 0 | 0 | - 1 | + 2 | - 2 | - 6 |
| New Orleans, La | - 2.4 | - 1 | 0 | - 1 | + 3 | + 2 | + 1 | + 1 | + 1 | - 1 | + 2 | - 1 | - 1 |
| Shreveport, La | - 0.7 | + 1 | - 3 | - 1 | + 4 | + 4 | - 1 | - 1 | - 1 | + 1 | + 4 | + 1 | - 4 |
| Fort Smith, Ark | + 2.2 | + 3 | - 5 | - 1 | + 6 | + 2 | + 2 | - 1 | 0 | + 4 | + 6 | 0 | - 2 |
| Little Rock, Ark | - 0.2 | + 2 | - 7 | - 1 | + 6 | + 1 | - 1 | + 1 | + 2 | + 2 | + 3 | - 2 | - 4 |
| Palestine, Tex | + 0.4 | + 1 | - 5 | - 2 | + 3 | + 3 | + 1 | + 1 | + 2 | + 3 | + 5 | + 2 | 0 |
| Galveston, Tex | - 1.6 | - 1 | - 5 | - 2 | - 1 | + 3 | 0 | - 1 | 0 | - 1 | + 1 | + 3 | - 3 |
| San Antonio, Tex | 0.0 | 0 | - 6 | - 2 | - 1 | 0 | + 1 | - 3 | - 3 | + 3 | + 3 | + 2 | + 1 |
| Ohio Valley and Tennessee: | | | | | | | | | | | | | |
| Memphis, Tenn | - 0.1 | + 1 | - 5 | 0 | + 7 | + 2 | 0 | 0 | 0 | + 1 | + 1 | - 4 | - 6 |
| Nashville, Tenn | - 2.0 | - 1 | - 7 | + 3 | + 6 | + 2 | - 1 | + 1 | - 1 | + 1 | 0 | + 1 | - 7 |
| Chattanooga, Tenn | - 2.7 | - 1 | - 6 | + 2 | + 5 | + 1 | - 1 | + 3 | - 1 | + 2 | + 2 | 0 | - 6 |
| Louisville, Ky | - 1.1 | - 1 | -11 | + 4 | + 5 | - 2 | 0 | + 5 | + 1 | 0 | + 2 | - 1 | - 3 |
| Indianapolis, Ind | - 1.9 | 0 | - 9 | + 3 | + 6 | - 1 | + 2 | + 4 | + 4 | - 3 | 0 | - 2 | - 3 |
| Cincinnati, Ohio | - 2.5 | - 1 | -10 | + 5 | + 5 | - 1 | + 1 | + 4 | + 1 | - 2 | + 2 | - 2 | - 2 |
| Columbus, Ohio | - 1.4 | 0 | - 9 | + 6 | + 5 | - 4 | + 1 | + 8 | + 5 | + 1 | + 3 | - 2 | - 1 |
| Pittsburg, Pa | - 1.8 | + 1 | - 9 | + 9 | + 5 | - 4 | + 3 | + 8 | + 4 | + 1 | + 3 | - 2 | - 0 |
| Lake region: | | | | | | | | | | | | | |
| Oswego, N. Y | - 2.0 | - 1 | - 5 | + 9 | + 1 | - 4 | - 3 | 0 | + 4 | + 1 | + 2 | - 4 | - 2 |
| Buffalo, N. Y | - 0.8 | - 2 | - 4 | +12 | + 4 | - 4 | - 3 | + 2 | + 5 | + 1 | + 5 | 0 | + 1 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cleveland, Ohio | − 1.5 | − 1 | − 6 | +10 | + 4 | − 4 | + 3 | + 5 | + 2 | 0 | + 1 | − 3 | − 3 |
| Detroit, Mich | − 2.2 | + 1 | − 7 | + 7 | + 8 | − 2 | + 3 | + 3 | + 5 | 0 | + 1 | − 4 | − 1 |
| Grand Haven, Mich | − 1.8 | + 1 | − 5 | + 5 | + 9 | − 3 | + 3 | + 1 | + 4 | − 1 | 0 | − 3 | − 1 |
| Milwaukee, Wis | + 0.6 | + 7 | − 4 | + 5 | + 9 | + 4 | +10 | + 3 | + 8 | − 1 | + 3 | − 3 | − 2 |
| Chicago, Ill | − 2.1 | + 2 | − 8 | + 6 | + 3 | + 1 | + 6 | − 2 | + 3 | − 1 | + 3 | − 7 | − 6 |
| Duluth, Minn | − 0.5 | +10 | − 1 | + 9 | + 7 | + 3 | + 5 | + 5 | + 9 | + 1 | + 2 | − 7 | + 4 |
| Upper Mississippi Valley: | | | | | | | | | | | | | |
| St. Paul, Minn | + 0.8 | + 9 | − 2 | + 6 | +12 | + 1 | +11 | + 1 | + 7 | + 2 | + 2 | − 2 | + 3 |
| La Crosse, Wis | − 1.2 | + 6 | − 4 | + 4 | +10 | − 1 | + 7 | 0 | + 5 | + 2 | + 5 | − 3 | + 1 |
| Davenport, Iowa | − 0.8 | + 4 | − 7 | + 5 | + 8 | + 1 | + 6 | − 1 | + 6 | + 3 | + 3 | − 3 | − 2 |
| Des Moines, Iowa | + 1.0 | + 7 | − 5 | + 5 | + 8 | + 1 | + 8 | − 2 | + 7 | + 5 | + 2 | − 4 | + 1 |
| Springfield, Ill | + 0.2 | + 3 | − 8 | + 4 | + 6 | 0 | + 3 | + 1 | + 6 | + 3 | + 3 | − 4 | − 2 |
| Cairo, Ill | − 0.2 | 0 | − 7 | + 1 | + 7 | + 2 | 0 | + 2 | + 2 | + 2 | + 1 | − 1 | − 5 |
| St. Louis, Mo | + 0.6 | + 3 | − 7 | + 3 | + 8 | + 1 | + 3 | + 2 | + 5 | + 1 | + 2 | − 3 | − 4 |
| Missouri Valley: | | | | | | | | | | | | | |
| Springfield, Mo | + 0.1 | + 2 | − 8 | + 1 | + 7 | + 1 | + 4 | + 2 | + 4 | + 4 | + 5 | − 3 | − 3 |
| Kansas City, Mo | + 1.5 | + 6 | − 5 | + 4 | + 9 | + 3 | + 6 | − 5 | + 3 | + 4 | + 4 | − 3 | − 1 |
| Concordia, Kans | + 3.5 | + 3 | − 7 | 0 | + 5 | + 3 | + 9 | − 3 | + 3 | + 3 | + 5 | − 2 | + 2 |
| Omaha, Nebr | + 1.7 | + 5 | − 5 | + 4 | + 8 | + 2 | + 9 | − 3 | + 6 | + 4 | + 5 | − 3 | 0 |
| Valentine, Nebr | + 5.1 | + 7 | − 5 | + 5 | + 4 | + 8 | +11 | + 1 | + 6 | + 6 | + 3 | − 3 | + 7 |
| Huron, S. Dak | + 5.1 | + 9 | − 2 | + 6 | +10 | + 4 | +12 | + 2 | +10 | + 5 | + 3 | − 3 | + 5 |
| Extreme Northwest: | | | | | | | | | | | | | |
| Moorhead, Minn | + 5.6 | +13 | 0 | + 9 | +12 | + 2 | +13 | + 2 | +11 | + 4 | 0 | − 3 | + 7 |
| Bismarck, N. Dak | + 3.1 | +13 | 0 | +13 | +10 | + 5 | +15 | − 1 | +10 | + 7 | + 2 | + 1 | +11 |
| Williston, N. Dak | + 3.8 | +13 | + 1 | +11 | + 9 | + 8 | +16 | 0 | + 8 | + 8 | + 3 | + 3 | +17 |
| Rocky Mountain slope: | | | | | | | | | | | | | |
| Havre, Mont | + 6.3 | +10 | + 2 | + 6 | + 3 | + 8 | +13 | + 2 | + 1 | + 2 | + 2 | + 5 | +17 |
| Helena, Mont | + 7.0 | + 7 | 0 | + 7 | − 1 | +10 | + 7 | + 1 | 0 | 0 | + 5 | + 4 | +15 |
| Spokane, Wash | + 6.8 | + 1 | + 4 | + 4 | − 1 | +10 | + 6 | 0 | − 9 | − 4 | 0 | + 5 | +10 |
| Salt Lake City, Utah | + 5.6 | − 2 | − 4 | + 4 | − 4 | + 2 | + 4 | − 2 | + 6 | + 7 | + 4 | + 2 | +10 |
| Cheyenne, Wyo | + 2.4 | + 2 | − 8 | + 2 | + 1 | + 2 | + 8 | − 4 | + 5 | + 8 | + 3 | + 1 | + 5 |
| North Platte, Nebr | + 4.7 | + 7 | − 4 | + 1 | + 4 | + 6 | +10 | − 2 | + 3 | + 7 | + 5 | 0 | + 4 |
| Denver, Colo | + 3.7 | 0 | −11 | + 2 | − 1 | + 1 | + 9 | − 3 | + 5 | + 7 | + 3 | 0 | + 5 |
| Dodge, Kans | + 4.2 | + 5 | − 6 | − 2 | + 5 | + 3 | + 7 | − 6 | 0 | + 4 | + 4 | − 2 | − 2 |
| Abilene, Tex | + 2.2 | + 1 | − 9 | − 2 | − 1 | − 2 | + 1 | − 5 | − 5 | − 1 | + 5 | + 4 | − 2 |
| Santa Fe, N. Mex | + 4.6 | − 3 | − 6 | 0 | − 5 | − 1 | + 6 | − 1 | + 1 | + 4 | + 4 | + 1 | + 2 |
| El Paso, Tex | + 1.8 | − 5 | − 7 | − 2 | − 6 | − 1 | + 2 | − 1 | 0 | + 2 | + 4 | + 3 | + 1 |
| Phoenix, Ariz | + 4.8 | − 7 | − 5 | 0 | − 8 | − 2 | + 2 | + 4 | + 5 | + 4 | + 3 | 0 | + 5 |
| Pacific coast: | | | | | | | | | | | | | |
| Seattle, Wash | + 4.0 | 0 | + 3 | + 2 | 0 | + 6 | + 1 | + 1 | − 4 | + 2 | + 1 | + 5 | + 2 |
| Portland, Oreg | + 3.7 | − 2 | + 2 | 0 | 0 | + 5 | 0 | + 1 | − 7 | 0 | + 3 | + 3 | + 2 |
| Roseburg, Oreg | + 3.6 | − 2 | + 2 | + 2 | − 2 | + 5 | + 2 | + 1 | − 5 | − 2 | + 4 | + 3 | + 3 |
| Red Bluff, Cal | + 3.2 | − 2 | − 2 | − 2 | − 1 | − 2 | − 3 | + 5 | − 4 | + 2 | +10 | − 4 | + 1 |
| Sacramento, Cal | + 2.0 | − 1 | 0 | − 2 | − 2 | − 2 | − 1 | + 6 | − 1 | − 1 | + 5 | − 3 | + 3 |
| San Francisco, Cal | + 1.4 | − 1 | + 1 | − 2 | − 1 | + 1 | + 1 | + 2 | − 2 | − 4 | − 1 | − 1 | + 1 |
| Los Angeles, Cal | + 4.1 | 0 | − 1 | − 2 | − 5 | − 1 | + 1 | + 4 | + 4 | + 1 | + 2 | 0 | + 3 |
| San Diego, Cal | + 3.4 | − 1 | − 1 | − 1 | − 4 | 0 | 0 | + 1 | + 1 | 0 | + 2 | − 1 | + 1 |

*Average daily temperature departures (degrees Fahrenheit) for season of 1900 from normal based upon observations for many years, by stations.*

| Stations. | For weeks ending— | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | July— | | | | | August— | | | | September— | | | | October— | |
| | 2. | 9. | 16. | 23. | 30. | 6. | 13. | 20. | 27. | 3. | 10. | 17. | 24. | 1. | 8. |
| New England: | | | | | | | | | | | | | | | |
| Eastport, Me | +1 | +2 | +1 | 0 | +1 | -2 | +2 | -1 | +3 | +4 | +5 | +1 | -1 | +2 | +4 |
| Portland, Me | +1 | 0 | +1 | +3 | +1 | -3 | +4 | -3 | +3 | +5 | +6 | 0 | -1 | +2 | +3 |
| Boston, Mass | +3 | +2 | +2 | +5 | +3 | +1 | +5 | -2 | +5 | +6 | +8 | +2 | -1 | +2 | +1 |
| Middle Atlantic States: | | | | | | | | | | | | | | | |
| Albany, N. Y | 0 | +3 | -1 | +6 | +2 | -3 | +8 | +1 | +7 | +10 | +7 | +3 | -1 | +10 | +14 |
| New York City | +3 | +4 | +2 | +7 | +2 | 0 | +9 | +2 | +1 | +9 | +9 | +6 | -1 | +6 | +9 |
| Philadelphia, Pa | +3 | +6 | +1 | +8 | +1 | -1 | +11 | +6 | +2 | +9 | +9 | +6 | -1 | +7 | +9 |
| Washington, D. C | +2 | +5 | -1 | +7 | -1 | -2 | +10 | +7 | +3 | +9 | +11 | +7 | -1 | +7 | +11 |
| Lynchburg, Va | 0 | +5 | -3 | +6 | -2 | 0 | +8 | +8 | +6 | +7 | +8 | +7 | -1 | +8 | +10 |
| Norfolk, Va | +3 | +7 | -1 | +6 | 0 | -1 | +9 | +6 | +6 | +7 | +7 | +8 | -1 | +6 | +9 |
| South Atlantic States: | | | | | | | | | | | | | | | |
| Charlotte, N. C | +2 | +4 | -2 | +4 | -2 | +2 | +8 | +7 | +5 | +6 | +6 | +7 | +1 | +9 | +7 |
| Wilmington, N. C | +1 | +4 | -1 | +4 | +1 | -2 | +5 | +7 | +6 | +3 | +2 | +6 | +1 | +4 | +9 |
| Charleston, S. C | +2 | +3 | -2 | +3 | +1 | -1 | +3 | +6 | +6 | +3 | +2 | +5 | +4 | +5 | +6 |
| Augusta, Ga | 0 | +4 | -2 | +1 | -1 | +2 | +4 | +7 | +5 | +4 | +4 | +5 | +2 | +9 | +9 |
| Savannah, Ga | +2 | +2 | -2 | 0 | 0 | +1 | +3 | +5 | +5 | +3 | +2 | +3 | +3 | +7 | +7 |
| Jacksonville, Fla | +3 | +2 | -2 | 0 | 0 | 0 | +1 | +5 | +5 | +3 | +1 | +3 | +2 | +5 | +4 |
| Gulf States: | | | | | | | | | | | | | | | |
| Atlanta, Ga | 0 | +3 | -2 | +2 | -1 | +2 | +7 | +4 | +5 | +4 | +5 | +5 | +1 | +10 | +6 |
| Mobile, Ala | -2 | +2 | -2 | -1 | -1 | +1 | 0 | +2 | +3 | 0 | +3 | +3 | +3 | +7 | +5 |
| Montgomery, Ala | -1 | +1 | -3 | -1 | 0 | +2 | +3 | +4 | +4 | +1 | +2 | +3 | +2 | +9 | +7 |
| Vicksburg, Miss | -1 | +1 | -2 | 0 | -3 | +1 | 0 | +1 | +3 | +2 | +4 | +6 | +4 | +9 | +6 |
| New Orleans, La | 0 | +1 | -2 | -3 | -1 | 0 | 0 | +2 | +3 | +1 | +2 | +3 | +6 | +7 | +4 |
| Shreveport, La | +1 | +1 | -3 | -1 | -2 | -1 | -2 | +1 | +3 | +1 | +5 | +8 | +5 | +10 | +8 |
| Fort Smith, Ark | +2 | +3 | -1 | -1 | -2 | +2 | +2 | +6 | +7 | +6 | +6 | +6 | +1 | +10 | +9 |
| Little Rock, Ark | +1 | +3 | -2 | -1 | -1 | +1 | +2 | +4 | +3 | +3 | +6 | +5 | +1 | +10 | +6 |
| Palestine, Tex | +2 | 0 | -3 | 0 | -2 | -2 | -3 | -1 | +3 | +2 | +3 | +6 | +7 | +9 | +7 |
| Galveston, Tex | 0 | -1 | -2 | 0 | -3 | -1 | -4 | +1 | +1 | +2 | +2 | +6 | +7 | +7 | +8 |
| San Antonio, Tex | +1 | 0 | -2 | 0 | 0 | -2 | 0 | 0 | +2 | +3 | +1 | +5 | +7 | +7 | +7 |
| Ohio Valley and Tennessee: | | | | | | | | | | | | | | | |
| Memphis, Tenn | -1 | +2 | -2 | -1 | -1 | +3 | +3 | +4 | +4 | +2 | +7 | +8 | +1 | +10 | +7 |
| Nashville, Tenn | -1 | +2 | -2 | +2 | -1 | +2 | +5 | +7 | +6 | +4 | +7 | +7 | 0 | +10 | +10 |
| Chattanooga, Tenn | +1 | +4 | -2 | +3 | -1 | +3 | +6 | +5 | +7 | +5 | +7 | +5 | +1 | +11 | +10 |
| Louisville, Ky | 0 | +4 | -2 | +1 | -2 | +3 | +6 | +7 | +7 | +7 | +9 | +8 | -3 | +9 | +11 |
| Indianapolis, Ind | 0 | +3 | -3 | 0 | -3 | +4 | +6 | +4 | +7 | +7 | +7 | +5 | -1 | +7 | +12 |
| Cincinnati, Ohio | 0 | +2 | -3 | +2 | -2 | +1 | +6 | +6 | +6 | +7 | +7 | +6 | -1 | +9 | +11 |
| Columbus, Ohio | +2 | +6 | -2 | +4 | -1 | +2 | +8 | +6 | +7 | +8 | +7 | +6 | -3 | +9 | +13 |
| Pittsburg, Pa | 0 | +5 | -2 | +5 | 0 | -1 | +11 | +6 | +7 | +9 | +8 | +5 | -1 | +10 | +15 |
| Lake region: | | | | | | | | | | | | | | | |
| Oswego, N. Y | -1 | +2 | -2 | +3 | 0 | -2 | +7 | +1 | +6 | +7 | +3 | +4 | -3 | +3 | +15 |
| Buffalo, N. Y | +3 | +2 | -2 | +4 | +1 | 0 | +5 | +3 | +7 | +11 | +4 | +6 | -1 | +7 | +17 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cleveland, Ohio | +1 | +6 | −1 | +3 | −1 | −1 | +10 | +5 | +6 | +6 | +5 | +3 | −3 | +6 | +14 |
| Detroit, Mich | −2 | +4 | −2 | +2 | −2 | +2 | +9 | +6 | +7 | +7 | +6 | +4 | −4 | +7 | +14 |
| Grand Haven, Mich | −1 | +2 | −3 | 0 | −3 | +5 | +8 | +6 | +7 | +7 | +5 | +3 | −3 | +2 | +11 |
| Milwaukee, Wis | −2 | +7 | +1 | −3 | −1 | +5 | +11 | +5 | +5 | +8 | +6 | +5 | −1 | +5 | +9 |
| Chicago, Ill | +1 | +5 | −1 | −3 | −4 | +5 | +9 | +4 | +4 | +5 | +3 | +5 | −4 | +4 | +12 |
| Duluth, Minn | −1 | −4 | −2 | 0 | +2 | +3 | +1 | +4 | +4 | +4 | +7 | 0 | +1 | +2 | +5 |
| Upper Mississippi Valley: | | | | | | | | | | | | | | | |
| St. Paul, Minn | +3 | +2 | −2 | −3 | 0 | +8 | +8 | +10 | +6 | +7 | +8 | +1 | −4 | +1 | +9 |
| La Crosse, Wis | +1 | +3 | −4 | −5 | −2 | +6 | +9 | +10 | +7 | +8 | +7 | +2 | −4 | +2 | +10 |
| Davenport, Iowa | +1 | +4 | −1 | −4 | −2 | +8 | +9 | +5 | +7 | +6 | +6 | +1 | −2 | +3 | +11 |
| Des Moines, Iowa | +1 | +4 | 0 | −4 | −1 | +7 | +6 | +4 | +6 | +6 | +8 | +1 | −4 | 0 | +9 |
| Springfield, Ill | +2 | +4 | −1 | −2 | −2 | +6 | +7 | +7 | +7 | +6 | +7 | +3 | −3 | +4 | +8 |
| Cairo, Ill | 0 | +2 | −1 | 0 | −1 | +3 | +5 | +6 | +4 | +4 | +9 | +7 | +1 | +7 | +9 |
| St. Louis, Mo | +3 | +3 | 0 | −2 | −2 | +6 | +7 | +9 | +6 | +6 | +7 | +6 | −1 | +6 | +10 |
| Missouri Valley: | | | | | | | | | | | | | | | |
| Springfield, Mo | +1 | +4 | +1 | −2 | −2 | +3 | +3 | +7 | +6 | +5 | +9 | +2 | −1 | +9 | +9 |
| Kansas City, Mo | +3 | +3 | 0 | −3 | −1 | +5 | +5 | +7 | +2 | +4 | +10 | +1 | +1 | +1 | +10 |
| Concordia, Kans | +10 | +7 | +6 | −3 | −4 | +6 | +5 | +11 | +7 | +6 | +12 | 0 | −4 | 0 | +13 |
| Omaha, Nebr | +3 | +3 | 0 | −5 | −2 | +6 | +4 | +5 | +4 | +5 | +8 | +2 | −1 | +1 | +11 |
| Valentine, Nebr | +5 | −3 | −2 | −6 | −2 | +9 | +2 | +3 | +4 | +7 | +10 | +1 | −3 | −7 | +2 |
| Huron, S. Dak | +4 | +2 | −1 | −3 | 0 | +13 | +6 | +7 | +3 | +7 | +8 | −1 | −2 | −4 | +4 |
| Extreme Northwest: | | | | | | | | | | | | | | | |
| Moorhead, Minn | −1 | +1 | −1 | 0 | 0 | +8 | +9 | +9 | +5 | +9 | +9 | −3 | 0 | −3 | +4 |
| Bismarck, N. Dak | −2 | 0 | 0 | +1 | +3 | +8 | +4 | +5 | +2 | +6 | +7 | −4 | 0 | −7 | −4 |
| Williston, N. Dak | −1 | 0 | +2 | 0 | +5 | +8 | +2 | +4 | −1 | +1 | +4 | −3 | +2 | −8 | −7 |
| Rocky Mountain slope: | | | | | | | | | | | | | | | |
| Havre, Mont | 0 | −1 | +1 | +1 | +4 | +2 | −1 | +2 | −2 | 0 | +5 | 0 | +1 | −11 | −9 |
| Helena, Mont | 0 | −5 | 0 | +1 | +4 | +2 | −6 | −1 | −6 | +1 | +4 | −1 | −2 | −11 | −9 |
| Spokane, Wash | −2 | −4 | −1 | +3 | +4 | −4 | −9 | −2 | −4 | −2 | +4 | +3 | 0 | −5 | −7 |
| Salt Lake City, Utah | +5 | −4 | +2 | −2 | +1 | +1 | −2 | 0 | −4 | +6 | +5 | +4 | −6 | −9 | 0 |
| Cheyenne, Wyo | +7 | −2 | −1 | −4 | −2 | +3 | +1 | +4 | 0 | +5 | +9 | +1 | −1 | −8 | +1 |
| North Platte, Nebr | +7 | +2 | +3 | −4 | −2 | +7 | +5 | +5 | +3 | +6 | +13 | +2 | 0 | −3 | +4 |
| Denver, Colo | +6 | −1 | +3 | −4 | −1 | +4 | +1 | +3 | 0 | +6 | +7 | 0 | −2 | −4 | +2 |
| Dodge, Kans | +7 | +2 | +1 | −2 | −3 | +2 | +4 | +9 | +5 | +5 | +10 | +1 | +1 | −2 | +9 |
| Abilene, Tex | +4 | +2 | −2 | −4 | −4 | −4 | −3 | 0 | +7 | +3 | +1 | +5 | −1 | +6 | +6 |
| Santa Fe, N. Mex | +4 | −3 | +4 | +1 | +2 | +1 | 0 | +2 | +3 | +7 | +1 | +2 | −1 | 0 | +1 |
| El Paso, Tex | +1 | −3 | +1 | −1 | −1 | −1 | 0 | +2 | +4 | +5 | +2 | +7 | +3 | +5 | +5 |
| Phoenix, Ariz | +4 | −1 | +7 | −1 | +2 | +1 | −4 | −2 | −2 | +1 | 0 | −1 | +1 | −5 | +2 |
| Pacific coast: | | | | | | | | | | | | | | | |
| Seattle, Wash | 0 | −2 | +1 | +5 | +3 | +1 | −1 | +1 | −1 | +1 | +2 | +2 | +1 | −1 | −2 |
| Portland, Oreg | −3 | −3 | −1 | +3 | +1 | −1 | −4 | −3 | −2 | +1 | −1 | +1 | −2 | −2 | −5 |
| Roseburg, Oreg | −2 | −3 | −1 | +3 | +1 | −2 | −5 | −3 | 0 | 0 | −2 | 0 | −1 | −3 | −6 |
| Red Bluff, Cal | −1 | +2 | +1 | +2 | 0 | −2 | −9 | −8 | 0 | −1 | −8 | −8 | +1 | −2 | −9 |
| Sacramento, Cal | 0 | +4 | +1 | −1 | +2 | 0 | −5 | −6 | +1 | −1 | −6 | −6 | +3 | 0 | −6 |
| San Francisco, Cal | 0 | +1 | −2 | −1 | +1 | +4 | −1 | 0 | +2 | +2 | +1 | 0 | +9 | +3 | 0 |
| Los Angeles, Cal | +1 | −1 | +5 | 0 | +3 | +3 | −3 | −5 | −2 | −2 | −3 | −6 | +1 | +2 | −2 |
| San Diego, Cal | 0 | −1 | +1 | +1 | +2 | +1 | −4 | −4 | −2 | −2 | −2 | −3 | −1 | +2 | −2 |

*Precipitation departures (inches and hundredths) for the season of 1900 from normal based upon observations for many years, by sections.*

| Sections. | From Jan. 1 to Apr. 2, inclusive. | For weeks ending— April— 9. | April— 16. | April— 23. | April— 30. | May— 7. | May— 14. | May— 21. | May— 28. | June— 4. | June— 11. | June— 18. | June— 25. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Middle and South Atlantic States | −0.34 | −0.68 | −0.06 | +1.93 | −0.50 | −0.38 | −0.61 | +0.42 | +0.14 | −0.42 | +0.33 | +0.83 | +0.78 |
| Gulf States | −.57 | −.19 | +.09 | +2.08 | +.26 | −.65 | −.40 | −.10 | −.20 | +1.96 | −.23 | +.33 | +1.28 |
| Ohio Valley and Tennessee | −3.89 | −.54 | +.02 | +.72 | −.79 | −.77 | −.21 | −.14 | −.44 | +.86 | +.05 | +.30 | −.07 |
| Lake region | +1.14 | −.48 | −.21 | +.19 | −.62 | −.59 | +.18 | −.37 | −.60 | −.26 | +.04 | −.67 | −.63 |
| Upper Mississippi and Missouri valleys | −1.30 | −.57 | +.39 | +.10 | −.02 | −.29 | −.54 | +.22 | −.74 | −.47 | −.20 | +.23 | −.45 |
| Rocky Mountain region | −.82 | +.79 | +.52 | −.03 | +.56 | −.10 | −.20 | +.03 | −.14 | −.01 | −.30 | −.10 | −.28 |
| North Pacific coast | −4.17 | −.01 | −.10 | −.57 | −.53 | +.37 | +.48 | −.30 | +.93 | −.41 | −.30 | +.10 | +1.01 |
| California | −4.69 | −.21 | −.14 | +.22 | −.15 | +.96 | +.09 | −.15 | −.12 | −.08 | −.07 | +.04 | +.08 |

| Sections. | For weeks ending— July— 2. | July— 9. | July— 16. | July— 23. | July— 30. | August— 6. | August— 13. | August— 20. | August— 27. | September— 3. | September— 10. | September— 17. | September— 24. | October— 1. | October— 8. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Middle and South Atlantic States | −0.27 | −0.60 | −0.72 | −0.85 | −0.03 | −0.80 | −1.16 | −0.65 | +0.10 | −0.65 | −0.87 | −0.68 | −0.91 | −0.45 | +0.24 |
| Gulf States | +1.21 | −.52 | +1.28 | +.17 | +.45 | −.14 | −.10 | −.58 | −.11 | +.08 | −.15 | +.16 | +.03 | −.77 | +.21 |
| Ohio Valley and Tennessee | +.46 | −.33 | −.65 | +.33 | +.27 | −.51 | −.40 | −.20 | +.14 | −.14 | −.68 | −.50 | +.03 | −.21 | +.54 |
| Lake region | −.67 | +.79 | −.27 | −.02 | +.30 | −.20 | +.17 | +.24 | +.66 | −.19 | −.36 | −.28 | −.03 | −.07 | +.11 |
| Upper Mississippi and Missouri valleys | −.32 | +.21 | +1.12 | +.22 | +.33 | −.35 | +.26 | +.16 | +.62 | −.19 | −.32 | +.46 | +.51 | +.78 | +.51 |
| Rocky Mountain region | −.24 | +.16 | −.25 | −.04 | +.12 | −.17 | −.14 | −.34 | −.07 | .00 | +.51 | +.08 | +.60 | −.04 | .00 |
| North Pacific coast | −.12 | +.10 | −.14 | −.12 | −.12 | −.06 | +.52 | −.09 | +.03 | −.16 | +.29 | −.06 | +.03 | −.54 | −.49 |
| California | −.02 | .00 | .00 | .00 | .00 | −.01 | .00 | .00 | .00 | −.02 | −.01 | +.06 | −.09 | −.11 | +.48 |

*Precipitation departures (inches and hundredths) for the season of 1900 from normal based upon observations for many years, by stations.*

| Stations. | From Jan. 1 to Apr. 2, inclusive. | For weeks ending— April— 9. | April— 16. | April— 23. | April— 30. | May— 7. | May— 14. | May— 21. | May— 28. | June— 4. | June— 11. | June— 18. | June— 25. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New England: | | | | | | | | | | | | | |
| Eastport, Me | +2.45 | −0.36 | −0.24 | +0.57 | −0.30 | +0.79 | −0.34 | +2.15 | −0.75 | +0.28 | −0.22 | −0.24 | −0.80 |
| Portland, Me | +10.88 | −.06 | −.39 | +.40 | −.53 | +1.11 | −.56 | +1.10 | −.80 | −.60 | −.73 | −.23 | −.36 |
| Boston, Mass | +3.68 | −.39 | −.20 | −.03 | −.70 | +1.65 | −.52 | +1.35 | −.66 | −.34 | −.61 | −.63 | +.23 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Middle Atlantic States:** | | | | | | | | | | | | | |
| Albany, N. Y | + 1.42 | − .56 | − .28 | + .33 | − .55 | − .60 | − .52 | + .39 | − .72 | − .09 | − .18 | + .44 | − .73 |
| New York City | + .45 | − .83 | + .15 | + .31 | − .71 | − .48 | − .45 | +1.86 | − .15 | + .09 | + .02 | − .01 | − .75 |
| Philadelphia, Pa | + .14 | − .70 | − .27 | + .91 | − .70 | − .34 | − .54 | +2.39 | − .29 | − .19 | − .25 | + .61 | − .77 |
| Washington, D. C | − 1.02 | − .80 | − .20 | + .32 | − .68 | − .61 | − .49 | +2.25 | − .72 | +2.71 | +1.93 | +3.31 | − .96 |
| Lynchburg, Va | + 1.79 | − .69 | − .24 | +2.36 | − .83 | − .81 | − .60 | + .07 | +1.68 | − .59 | − .11 | +5.05 | − .16 |
| Norfolk, Va | − 2.51 | − .76 | +1.62 | + .69 | − .91 | − .59 | − .67 | − .54 | + .68 | − .98 | − .98 | + .60 | − .88 |
| **South Atlantic States:** | | | | | | | | | | | | | |
| Charlotte, N. C | − 1.90 | − .02 | − .14 | +2.71 | − .51 | − .59 | − .68 | − .25 | − .26 | −1.02 | + .12 | +1.08 | +1.07 |
| Wilmington, N. C | + .07 | − .61 | − .20 | + .67 | − .75 | − .60 | − .64 | − .67 | +1.52 | −1.11 | − .18 | + .29 | − .64 |
| Charleston, S. C | − 2.59 | − .84 | − .28 | + .90 | + .30 | − .73 | − .85 | .00 | − .61 | −1.10 | − .21 | + .13 | +2.32 |
| Augusta, Ga | − 1.99 | − .83 | − .06 | +6.02 | − .62 | − .18 | − .59 | − .14 | − .17 | − .47 | + .81 | + .36 | +1.45 |
| Savannah, Ga | − .71 | − .84 | − .66 | +2.11 | + .86 | + .24 | − .46 | + .46 | + .23 | −1.18 | − .09 | − .80 | +1.51 |
| Jacksonville, Fla | + 2.80 | − .68 | − .18 | +5.84 | − .50 | + .72 | − .79 | − .83 | + .44 | −1.09 | +3.11 | −1.10 | +2.55 |
| **Gulf States:** | | | | | | | | | | | | | |
| Atlanta, Ga | + 1.14 | − .80 | + .61 | +2.23 | + .84 | − .73 | − .40 | + .07 | + .34 | + .64 | +1.04 | + .03 | +3.84 |
| Mobile, Ala | + 3.22 | −1.25 | + .12 | +4.45 | − .44 | − .86 | − .88 | − .61 | − .66 | +9.22 | − .60 | +5.14 | +2.42 |
| Montgomery, Ala | − .10 | − .80 | + .42 | +1.17 | + .09 | − .47 | − .48 | − .47 | + .86 | − .95 | +1.14 | + .08 | +1.40 |
| Vicksburg, Miss | − 5.99 | −1.12 | +1.92 | +4.58 | −1.25 | −1.19 | −1.14 | − .16 | + .06 | +4.56 | − .86 | − .26 | +3.94 |
| New Orleans, La | − 2.21 | −1.19 | + .58 | +7.63 | −1.14 | −1.10 | − .97 | − .92 | −1.15 | +2.51 | − .46 | − .61 | + .11 |
| Shreveport, La | − .89 | − .80 | − .05 | +1.41 | − .67 | − .70 | − .17 | +1.24 | − .71 | +1.00 | + .63 | − .91 | +2.26 |
| Fort Smith, Ark | − 2.16 | − .86 | − .35 | − .03 | + .42 | − .24 | − .93 | − .39 | − .24 | +1.32 | − .24 | − .49 | − .79 |
| Little Rock, Ark | − 7.40 | − .14 | + .45 | − .67 | − .61 | − .99 | +1.28 | −1.32 | −1.26 | +1.68 | − .31 | + .77 | − .76 |
| Palestine, Tex | + .22 | +1.17 | − .89 | +1.53 | + .85 | −1.05 | − .44 | − .02 | − .67 | + .78 | −1.12 | + .07 | − .47 |
| Galveston, Tex | + 3.86 | + .53 | − .67 | − .39 | +2.47 | − .72 | + .43 | + .05 | +1.39 | + .49 | −1.12 | −1.26 | +2.70 |
| San Antonio, Tex | + 4.22 | +3.67 | − .64 | +1.02 | +2.26 | + .94 | − .74 | +1.46 | − .12 | − .65 | − .62 | + .03 | − .57 |
| **Ohio Valley and Tennessee:** | | | | | | | | | | | | | |
| Memphis, Tenn | − 6.61 | − .25 | + .53 | + .54 | − .66 | −1.16 | − .91 | + .05 | − .48 | + .76 | + .47 | +5.09 | − .75 |
| Nashville, Tenn | − 7.29 | − .18 | + .18 | + .58 | −1.01 | − .91 | − .65 | − .41 | − .23 | +1.17 | +1.74 | + .15 | + .90 |
| Chattanooga, Tenn | − 2.30 | − .11 | +1.06 | +3.39 | − .75 | − .83 | − .68 | − .26 | − .54 | + .18 | + .74 | + .13 | +1.14 |
| Louisville, Ky | − 4.33 | −1.08 | − .18 | + .09 | − .72 | − .05 | + .19 | − .51 | − .36 | +2.62 | − .29 | − .55 | − .62 |
| Indianapolis, Ind | − 3.12 | − .83 | − .19 | − .05 | − .91 | − .87 | − .42 | + .93 | + .42 | +2.12 | .00 | −1.08 | + .53 |
| Cincinnati, Ohio | − 4.11 | − .70 | − .33 | + .20 | − .77 | − .71 | +1.30 | − .37 | − .28 | + .24 | − .87 | −1.01 | − .82 |
| Columbus, Ohio | − 1.28 | − .70 | − .41 | + .67 | − .82 | − .92 | − .21 | − .11 | − .95 | − .51 | − .61 | − .64 | − .22 |
| Pittsburg, Pa | − 2.07 | − .49 | − .48 | + .30 | − .70 | − .74 | − .31 | − .41 | − .68 | + .29 | − .58 | + .31 | − .75 |
| **Lake region:** | | | | | | | | | | | | | |
| Oswego, N. Y | + 3.43 | − .48 | − .08 | + .67 | − .53 | − .54 | + .44 | − .50 | − .70 | − .57 | + .13 | − .73 | − .73 |
| Buffalo, N. Y | + 4.33 | − .40 | − .24 | + .06 | − .63 | − .52 | + .12 | − .69 | − .80 | − .34 | − .42 | − .59 | − .71 |
| Cleveland, Ohio | − .58 | − .35 | − .09 | + .20 | − .59 | − .67 | − .18 | − .85 | − .88 | − .02 | − .05 | − .81 | − .74 |
| Detroit, Mich | + 3.14 | − .32 | − .09 | + .46 | − .60 | − .66 | + .76 | − .55 | − .68 | +1.01 | + .88 | + .08 | − .45 |
| Grand Haven, Mich | + 1.48 | − .53 | − .10 | + .18 | − .63 | − .46 | + .18 | + .12 | − .65 | − .17 | + .04 | − .72 | − .71 |
| Milwaukee, Wis | − .23 | − .61 | − .20 | + .53 | − .70 | − .71 | − .23 | + .28 | + .03 | − .83 | + .11 | − .86 | − .38 |
| Chicago, Ill | − .58 | − .70 | − .31 | − .24 | − .77 | − .48 | + .72 | + .05 | − .35 | − .22 | − .08 | − .65 | − .34 |
| Duluth, Minn | − 2.05 | − .48 | − .55 | − .35 | − .51 | − .70 | − .37 | − .83 | − .74 | − .96 | − .31 | −1.08 | −1.01 |
| **Upper Mississippi Valley:** | | | | | | | | | | | | | |
| St. Paul, Minn | − .57 | − .49 | − .40 | + .91 | − .57 | − .70 | − .43 | − .77 | − .78 | − .74 | − .37 | − .26 | − .73 |
| La Crosse, Wis | − .74 | − .46 | + .08 | +1.26 | − .60 | − .47 | + .13 | +1.51 | − .63 | − .79 | + .42 | −1.10 | − .97 |
| Davenport, Iowa | + 1.12 | − .58 | + .30 | + .45 | − .73 | − .40 | + .03 | +1.41 | − .83 | − .49 | − .91 | − .90 | − .34 |
| Des Moines, Iowa | − .39 | − .52 | + .82 | +1.52 | − .71 | − .14 | −1.02 | + .83 | − .76 | + .43 | − .85 | + .54 | −1.07 |
| Springfield, Ill | − 1.11 | − .78 | − .35 | − .75 | − .58 | − .62 | − .81 | + .15 | −1.04 | − .71 | −1.01 | − .42 | − .52 |
| Cairo, Ill | − 5.30 | − .59 | − .31 | − .75 | − .18 | − .28 | − .32 | − .71 | + .37 | + .55 | +3.05 | + .69 | +1.97 |
| St. Louis, Mo | − 1.50 | − .84 | + .05 | − .45 | − .48 | +1.77 | − .60 | − .57 | −1.09 | − .30 | − .97 | + .02 | − .49 |

*Precipitation departures (inches and hundredths) for the season of 1900 from normal based upon observations for many years, by stations*—Continued.

| Stations. | From Jan. 1 to Apr. 2, inclusive. | For weeks ending— | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | April— | | | | May— | | | | June— | | | |
| | | 9. | 16. | 23. | 30. | 7. | 14. | 21. | 28. | 4. | 11. | 18. | 25. |
| Missouri Valley: | | | | | | | | | | | | | |
| Springfield, Mo | −3.92 | −.31 | +.56 | +.14 | −.85 | −.80 | −.39 | −.65 | −.90 | −1.05 | +.34 | +2.72 | −.38 |
| Kansas City, Mo | −.44 | −.60 | +1.62 | −.39 | +.22 | −.80 | −.80 | +1.22 | −.99 | −1.16 | −.38 | −.43 | +.29 |
| Concordia, Kans | −.71 | −.41 | +1.58 | −.05 | +.95 | −.69 | −.71 | +.69 | −.75 | −.44 | +.40 | −1.01 | −.98 |
| Omaha, Nebr | −.68 | −.61 | +.27 | −.23 | +1.01 | −.26 | −.90 | +.52 | −1.03 | −.66 | −1.03 | +.87 | −1.33 |
| Valentine, Nebr | −2.22 | −.60 | +1.49 | +.18 | +.95 | −.26 | −.55 | −.27 | −.51 | −.06 | −.53 | −.75 | −.63 |
| Huron, S. Dak | −.50 | −.68 | −.66 | −.56 | +1.28 | −.14 | −.63 | −.70 | −.68 | −.69 | −.77 | +3.07 | −.84 |
| Extreme Northwest: | | | | | | | | | | | | | |
| Moorhead, Minn | −.43 | −.44 | −.55 | −.56 | +1.40 | −.56 | −.10 | −.56 | −.46 | +.20 | −.79 | −.72 | −.76 |
| Bismarck, N. Dak | +.50 | −.34 | −.49 | −.57 | −.19 | −.56 | −.56 | −.56 | −.04 | +.08 | −.93 | +.87 | −.28 |
| Williston, N. Dak | +.60 | −.12 | −.31 | −.37 | +.03 | −.29 | −.36 | −.39 | −.53 | +.60 | −.76 | −.57 | −.84 |
| Rocky Mountain slope: | | | | | | | | | | | | | |
| Havre, Mont | −.41 | −.15 | +.09 | +.27 | +.27 | −.28 | −.26 | −.04 | −.33 | −.25 | −.66 | −.43 | −.75 |
| Helena, Mont | −1.18 | −.18 | +.12 | +.49 | +1.00 | −.13 | +1.96 | +.01 | −.29 | −.23 | −.60 | −.49 | −.55 |
| Spokane, Wash | −1.12 | +.36 | −.15 | −.15 | −.27 | +.08 | −.22 | +.64 | +.30 | −.27 | −.44 | −.39 | −.03 |
| Salt Lake City, Utah | −2.82 | +.63 | +.17 | −.19 | +.23 | −.04 | −.36 | −.41 | −.35 | −.28 | −.15 | −.16 | −.14 |
| Cheyenne, Wyo | +.57 | +1.92 | +1.67 | +.20 | +2.36 | −.08 | −.52 | −.15 | −.45 | −.28 | −.39 | −.33 | +.44 |
| North Platte, Nebr | −.64 | −.17 | +.62 | +.36 | +.46 | −.46 | −.54 | −.58 | −.58 | .00 | −.57 | +.29 | −.80 |
| Denver, Colo | −.83 | +2.35 | +2.65 | −.22 | +1.47 | −.63 | −.70 | −.20 | −.56 | +.80 | +.01 | +.02 | −.32 |
| Dodge City, Kans | −.39 | +1.59 | +1.25 | −.38 | −.39 | +.31 | −.36 | −.21 | +.14 | −.84 | −.01 | +1.05 | −.77 |
| Abilene, Tex | −.61 | +1.53 | −.30 | −.37 | +1.41 | −.11 | −.77 | +.53 | +.26 | +.99 | −.81 | −.77 | −.74 |
| Santa Fe, N. Mex | −.07 | +.86 | +.75 | −.19 | .00 | +.11 | −.25 | +.76 | +.06 | +.33 | +.11 | +.03 | +.13 |
| El Paso, Tex | −.57 | −.01 | .00 | −.03 | −.07 | −.07 | −.05 | +.01 | +.06 | −.06 | −.07 | −.07 | +.18 |
| Phoenix, Ariz | −1.79 | +.73 | −.07 | −.07 | +.25 | +.05 | −.07 | −.02 | .00 | .00 | .00 | .00 | −.02 |
| Pacific coast: | | | | | | | | | | | | | |
| Seattle, Wash | −1.44 | +.23 | −.69 | −.62 | −.64 | +.01 | +.77 | −.22 | +1.21 | −.37 | −.08 | −.07 | +1.64 |
| Portland, Oreg | −6.44 | −.46 | −.09 | −.62 | −.56 | +.99 | +.12 | −.51 | +1.11 | −.48 | −.46 | −.10 | +.77 |
| Roseburg, Oreg | −4.53 | +.19 | +.48 | −.38 | −.40 | +.12 | +.54 | −.18 | +.48 | −.38 | −.35 | +.46 | +.51 |
| Redbluff, Cal | −2.75 | −.02 | −.04 | +.72 | −.42 | +.28 | +.09 | −.28 | −.24 | −.20 | −.14 | +.28 | +.47 |
| Sacramento, Cal | −4.22 | −.53 | −.08 | +.40 | −.45 | +2.15 | +.15 | −.20 | −.14 | −.08 | −.07 | −.06 | .00 |
| San Francisco, Cal | −4.68 | −.22 | −.07 | −.23 | −.32 | −.18 | +.01 | −.15 | −.08 | −.07 | −.06 | −.03 | −.06 |
| Los Angeles, Cal | −7.16 | −.28 | −.32 | +.12 | −.20 | +1.30 | +.25 | −.07 | −.07 | −.07 | −.06 | .00 | .00 |
| San Diego, Cal | −4.63 | +.02 | −.21 | +.10 | +.65 | +1.25 | −.04 | −.07 | −.06 | .00 | −.02 | +.04 | .00 |

*Precipitation departures (inches and hundredths) for the season of 1900 from normal based upon observations for many years, by stations.*

| Stations. | For weeks ending— | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | July— | | | | | August— | | | | September— | | | | October— | |
| | 2. | 9. | 16. | 23. | 30. | 6. | 13. | 20. | 27. | 3. | 10. | 17. | 24. | 1. | 8. |
| New England: | | | | | | | | | | | | | | | |
| Eastport, Me | +0.89 | −0.77 | −0.53 | −0.30 | −0.61 | −0.73 | +0.03 | +0.79 | −0.72 | −0.69 | −0.70 | +0.19 | −0.33 | −0.64 | −0.74 |
| Portland, Me | − .77 | − .62 | − .38 | − .60 | + .07 | − .85 | + .06 | +1.86 | − .78 | − .74 | − .70 | + .31 | + .56 | − .49 | − .67 |
| Boston, Mass | − .43 | − .66 | − .24 | − .56 | +1.05 | − .98 | − .39 | + .54 | − .91 | − .68 | − .53 | + .80 | +2.20 | − .56 | − .88 |
| Middle Atlantic States: | | | | | | | | | | | | | | | |
| Albany, N. Y | − .12 | − .58 | + 1.01 | − .79 | + .18 | − .96 | − .49 | +1.24 | − .68 | − .82 | − .84 | − .63 | − .36 | − .60 | − .77 |
| New York City | − .27 | + .51 | − .56 | − .59 | + .65 | − .61 | − .59 | − .01 | + .06 | − .97 | − .66 | + .82 | − .81 | − .42 | − .75 |
| Philadelphia, Pa | − .28 | − .33 | − .15 | − .93 | − .23 | − .37 | − .40 | − .09 | +1.38 | − .80 | − .78 | +3.10 | − .72 | +1.69 | − .02 |
| Washington, D. C | − .66 | − .98 | − 1.04 | − .32 | − .62 | − .59 | − .81 | − .75 | + .68 | − .72 | − .89 | +2.29 | − .77 | + .86 | − .45 |
| Lynchburg, Va | + .24 | − .58 | − .87 | − .06 | − .12 | − .89 | − .91 | − .07 | + .45 | − .81 | − .91 | +2.71 | − .06 | − .49 | − .61 |
| Norfolk, Va | − .21 | + .72 | − .90 | + .19 | +1.10 | −1.39 | −1.47 | + .22 | + .23 | −1.04 | −1.14 | − .34 | − .21 | − .57 | − .69 |
| South Atlantic States: | | | | | | | | | | | | | | | |
| Charlotte, N. C | + .68 | − .79 | − .83 | − .48 | + .29 | − .92 | −1.26 | − .67 | + .37 | − .06 | − .86 | − .06 | − .64 | − .78 | − .60 |
| Wilmington, N. C | − .34 | −1.50 | − 1.37 | −1.67 | −1.07 | + .05 | −1.74 | −1.68 | −1.47 | −1.55 | −1.58 | + .80 | −1.46 | −1.29 | +1.07 |
| Charleston, S. C | − 1.39 | −1.27 | − 1.62 | −1.76 | − .82 | −1.30 | −1.75 | −1.69 | −1.68 | − .51 | −1.56 | − .47 | −1.52 | −1.26 | − .26 |
| Augusta, Ga | + .81 | −1.19 | − .78 | −1.03 | +1.07 | −1.14 | −1.19 | −1.17 | +2.70 | − .30 | −1.05 | +1.06 | − .86 | − .66 | + .11 |
| Savannah, Ga | − .33 | − .76 | − .78 | −1.28 | − .61 | −1.28 | −1.78 | −1.64 | −1.11 | + .74 | − .52 | + .05 | −1.36 | − .94 | +3.73 |
| Jacksonville, Fla | − 1.32 | − .46 | − .77 | −1.46 | − .15 | − .33 | −1.47 | −1.46 | + .22 | − .92 | + .31 | −1.14 | −2.10 | − .94 | +2.13 |
| Gulf States: | | | | | | | | | | | | | | | |
| Atlanta, Ga | + .59 | − .58 | − .86 | −1.12 | +1.69 | − .92 | −1.12 | − .31 | − .42 | − .75 | − .95 | +2.72 | − .82 | − .74 | + .51 |
| Mobile, Ala | +13.00 | −1.28 | − .22 | − .73 | + .33 | +1.14 | −1.61 | − .61 | − .72 | − .86 | − .28 | +1.72 | −1.14 | −1.01 | +2.70 |
| Montgomery, Ala | + .17 | − .21 | + .61 | − .45 | − .38 | − .06 | − .98 | − .90 | − .03 | + .75 | − .73 | +3.34 | − .46 | − .62 | +1.55 |
| Vicksburg, Miss | + .30 | − .74 | − .80 | + .48 | +3.30 | − .87 | − .70 | − .76 | − .77 | − .79 | − .71 | − .88 | +1.15 | − .65 | + .72 |
| New Orleans, La | − 1.33 | −1.36 | − .86 | +2.49 | − .04 | − .38 | − .03 | − .91 | −1.17 | +1.01 | + .97 | − .60 | −1.00 | − .93 | + .74 |
| Shreveport, La | − .60 | − .84 | − .04 | +2.47 | + .93 | − .40 | + .11 | − .29 | + .70 | + .44 | − .83 | − .95 | +1.82 | − .69 | − .72 |
| Fort Smith, Ark | + 2.53 | − .99 | − .26 | − .87 | − .66 | − .88 | − .84 | − .84 | +1.80 | − .18 | − .25 | + .01 | +1.14 | − .72 | − .12 |
| Little Rock, Ark | + 19 | − .75 | − .19 | + .35 | + .46 | − .68 | − .46 | − .97 | +2.10 | + .28 | − .26 | − .44 | +1.37 | − .56 | − .09 |
| Palestine, Tex | − .17 | + .81 | + .13 | − .38 | − .29 | − .28 | +2.12 | − .31 | − .63 | + .26 | +1.39 | − .77 | + .08 | − .65 | − .70 |
| Galveston, Tex | − .84 | + .43 | +15.45 | − .09 | + .17 | +1.91 | +2.44 | −1.20 | −1.15 | −1.20 | + .72 | −1.55 | −1.20 | −1.19 | − .59 |
| San Antonio, Tex | − .52 | − .19 | + 1.13 | − .49 | − .19 | − .13 | − .62 | + .67 | − .96 | +1.94 | − .68 | − .83 | − .75 | − .64 | − .49 |
| Ohio Valley and Tennessee: | | | | | | | | | | | | | | | |
| Memphis, Tenn | +2.18 | − .67 | − .77 | + .07 | + .78 | − .77 | − .84 | − .84 | − .39 | − .36 | − .77 | − .59 | +1.50 | − .66 | − .01 |
| Nashville, Tenn | +2.26 | − .33 | − .98 | − .05 | + .35 | − .83 | − .75 | − .71 | − .37 | +2.89 | −1.01 | − .90 | + .56 | − .79 | + .79 |
| Chattanooga, Tenn | − .92 | − .93 | − .94 | − .80 | + .27 | − .91 | − .80 | − .70 | +1.04 | − .76 | − .87 | + .69 | − .80 | − .81 | + .12 |
| Louisville, Ky | + .13 | − .04 | − .84 | − .15 | + .31 | − .79 | + .40 | + .07 | + .48 | − .64 | − .70 | − .68 | − .30 | + .07 | +1.01 |
| Indianapolis, Ind | − .14 | − .16 | − .61 | + .79 | + .23 | − .84 | + .71 | − .12 | + .56 | − .38 | − .70 | − .70 | + .42 | + .88 | +1.45 |
| Cincinnati, Ohio | − .56 | − .36 | − .77 | + .89 | + .67 | +1.54 | − .66 | − .03 | − .07 | − .71 | − .62 | − .56 | − .30 | − .46 | + .75 |
| Columbus, Ohio | + .47 | − .64 | − .12 | +1.61 | + .14 | − .71 | − .70 | +1.16 | + .32 | − .67 | − .61 | − .63 | − .43 | + .21 | + .09 |
| Pittsburg, Pa | + .29 | + .51 | −1.15 | + .31 | − .59 | − .75 | − .56 | − .42 | − .49 | − .52 | − .18 | − .62 | − .42 | − .15 | + .11 |
| Lake region: | | | | | | | | | | | | | | | |
| Oswego, N. Y | − .73 | + .11 | + .27 | − .16 | + .26 | − .64 | +1.02 | − .38 | − .59 | − .32 | − .36 | − .19 | + .83 | − .38 | + .36 |
| Buffalo, N. Y | − .77 | + .19 | − .46 | + .23 | + .13 | − .67 | − .01 | +1.42 | + .11 | − .75 | − .09 | − .74 | + .42 | + .20 | + .50 |
| Cleveland, Ohio | − .67 | + .35 | + .20 | + .45 | + .57 | − .57 | − .40 | + .29 | − .21 | − .72 | − .12 | − .62 | − .43 | − .13 | − .01 |
| Detroit, Mich | − .74 | − .09 | − .70 | + .54 | + .89 | − .37 | − .38 | + .44 | − .11 | − .58 | − .48 | − .53 | − .03 | + .61 | + .24 |
| Grand Haven, Mich | − .67 | + .99 | − .23 | − .20 | + .28 | − .45 | + .27 | − .53 | +2.72 | + .17 | − .82 | − .38 | − .29 | − .59 | − .26 |

*Precipitation departures (inches and hundredths) for the season of 1900 from normal based upon observations for many years, by stations*—Continued.

| Stations. | For weeks ending— | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | July— | | | | | August— | | | | September— | | | | October. | |
| | 2. | 9. | 16. | 23. | 30. | 6. | 13. | 20. | 27. | 3. | 10. | 17. | 24. | 1. | 8. |
| Lake region—Continued. | | | | | | | | | | | | | | | |
| Milwaukee, Wis | -.74 | +1.96 | -.33 | -.30 | -.07 | -.02 | -.19 | -.33 | +1.82 | +1.41 | -.69 | -.11 | -.34 | -.24 | +.66 |
| Chicago, Ill | -.44 | +1.31 | -.74 | -.11 | +.71 | -.71 | -.13 | +1.30 | +1.08 | -.37 | -.70 | -.36 | -.27 | -.03 | -.63 |
| Duluth, Minn | -.63 | +1.51 | -.16 | -.65 | -.34 | +1.81 | +1.19 | -.25 | +.43 | -.34 | +.41 | +.67 | -.14 | .00 | +.50 |
| Upper Mississippi Valley: | | | | | | | | | | | | | | | |
| St. Paul, Minn | -.89 | +3.10 | +.35 | +.06 | -.70 | -.73 | +1.25 | -.73 | +.34 | -.22 | +1.77 | +4.44 | +.21 | -.29 | +4.35 |
| La Crosse, Wis | -.12 | +.27 | +4.22 | +.71 | +.37 | -.21 | +1.05 | -.68 | -.32 | -.26 | -.90 | +1.10 | -.54 | +.50 | +2.93 |
| Davenport, Iowa | -.83 | -.14 | +.23 | -.21 | +.30 | -.83 | +.50 | +2.34 | -.36 | -.73 | -.77 | -.76 | +1.26 | +.95 | -.34 |
| Des Moines, Iowa | +1.43 | -.23 | +.92 | +.30 | +.94 | -.77 | +1.00 | +4.17 | +.65 | -.70 | -.76 | +.09 | +1.06 | +.27 | -.02 |
| Springfield, Ill | -.52 | -.26 | +.45 | +.21 | -.18 | -.50 | +.32 | +.89 | +1.66 | +.20 | -.71 | -.77 | +.55 | +2.23 | -.27 |
| Cairo, Ill | +.20 | -.12 | -.61 | +1.02 | -.25 | -.69 | -.63 | -.63 | -.59 | -.32 | -.62 | -.49 | +1.02 | +.04 | -.22 |
| St. Louis, Mo | -.39 | -.60 | +.04 | +.02 | +.80 | -.84 | -.80 | -.68 | +.44 | -.49 | -.60 | -.72 | -.08 | +.91 | -.12 |
| Missouri Valley: | | | | | | | | | | | | | | | |
| Springfield, Mo | -.32 | -1.08 | +2.10 | +.07 | -.13 | -.99 | -.93 | -.89 | +2.27 | +1.79 | -.96 | +.19 | +.56 | +.81 | +.17 |
| Kansas City, Mo | +.37 | -.57 | -.55 | +.70 | +1.59 | -.91 | -.43 | -.66 | -.28 | +.06 | -.84 | -.34 | +1.66 | +3.62 | -.74 |
| Concordia, Kans | -.84 | -.69 | -.34 | +.47 | +.88 | -.59 | -.13 | -.63 | +1.84 | -.60 | -.56 | +2.43 | +.04 | -.43 | +.31 |
| Omaha, Nebr | -1.07 | -.68 | +3.02 | -.26 | +.32 | -.85 | +.23 | +.48 | +.52 | -.63 | -.70 | +1.01 | +1.02 | +.30 | -.56 |
| Valentine, Nebr | -.44 | +2.57 | +2.03 | +.27 | +.87 | +1.53 | +.01 | -.45 | +.96 | -.20 | +.01 | +.07 | -.03 | -.20 | -.05 |
| Huron, S. Dak | -.76 | +1.14 | +2.80 | -.50 | -.65 | +1.89 | +1.88 | -.45 | +.94 | -.32 | +1.47 | -.21 | -.12 | -.17 | +.24 |
| Extreme Northwest: | | | | | | | | | | | | | | | |
| Moorhead, Minn | +1.01 | +.40 | -.85 | -.61 | -.34 | +.67 | +2.85 | +1.59 | +2.00 | -.41 | +.29 | +.61 | +.43 | -.12 | +.77 |
| Bismarck, N. Dak | -.62 | +.45 | -.55 | -.50 | -.44 | -.12 | +1.29 | +.34 | -.38 | -.38 | +.82 | +1.24 | +1.05 | +.12 | -.18 |
| Williston, N. Dak | -.09 | +1.20 | -.49 | -.42 | -.22 | -.12 | +3.75 | -.14 | -.09 | -.04 | +.55 | +.36 | +.56 | +.48 | -.07 |
| Rocky Mountain slope: | | | | | | | | | | | | | | | |
| Havre, Mont | -.42 | -.25 | -.51 | -.45 | +.61 | -.36 | +.73 | -.26 | -.13 | +.30 | +.77 | -.10 | +.06 | +.28 | +.52 |
| Helena, Mont | -.41 | -.25 | -.25 | -.21 | -.04 | -.14 | +.12 | -.10 | +.15 | -.05 | +.46 | -.11 | +.03 | -.22 | +.90 |
| Spokane, Wash | -.25 | +.12 | -.19 | -.14 | -.10 | -.02 | +.31 | -.07 | +.02 | -.01 | +.43 | +.19 | +.33 | -.29 | +.59 |
| Salt Lake City, Utah | -.14 | +.12 | -.10 | -.03 | -.14 | +.06 | -.14 | -.14 | +.32 | -.21 | -.05 | -.21 | +.96 | -.14 | +.07 |
| Cheyenne, Wyo | -.15 | -.37 | .00 | -.42 | +.36 | +.02 | -.26 | -.35 | -.17 | -.25 | +1.09 | -.19 | -.04 | +.51 | -.19 |
| North Platte, Nebr | -.06 | +.37 | -.50 | +.34 | +.02 | -.50 | -.03 | -.56 | +.23 | -.44 | -.31 | -.10 | -.28 | -.21 | -.24 |
| Denver, Colo | -.35 | +.74 | -.33 | -.32 | -.35 | -.34 | -.34 | -.35 | -.32 | -.23 | -.06 | -.10 | -.14 | +.45 | -.21 |
| Dodge, Kans | -.72 | -.46 | -.37 | -.70 | +1.80 | -.69 | -.70 | -.56 | +.60 | -.37 | +.59 | +2.74 | -.22 | +.21 | -.28 |
| Abilene, Tex | -.35 | -.41 | +.37 | +.57 | +.10 | +.77 | -.33 | -.63 | -.63 | +.18 | +2.18 | -.56 | +6.29 | -.51 | -.56 |
| Santa Fe, N. Mex | -.27 | +2.14 | -.60 | -.55 | -.72 | -.25 | -.57 | -.52 | -.33 | -.19 | +1.78 | -.08 | +.03 | -.29 | -.27 |
| El Paso, Tex | +.26 | +.27 | -.36 | -.10 | +.17 | -.38 | -.16 | -.34 | -.36 | +1.22 | -.26 | -.28 | +.37 | -.09 | -.21 |
| Phoenix, Ariz | -.07 | -.12 | -.17 | +1.48 | -.28 | -.22 | -.26 | -.25 | -.19 | +.01 | -.07 | -.14 | -.14 | -.18 | -.14 |
| Pacific coast: | | | | | | | | | | | | | | | |
| Seattle, Wash | -.04 | +.30 | -.18 | -.21 | -.21 | -.14 | -.12 | -.09 | +.08 | -.15 | -.48 | -.37 | -.17 | -.61 | -.68 |
| Portland, Oreg | -.10 | +.15 | -.14 | -.09 | -.07 | -.04 | +1.70 | -.10 | +.04 | -.22 | +.33 | +.16 | +.30 | -.61 | -.64 |
| Roseburg, Oreg | -.21 | -.15 | -.10 | -.07 | -.07 | -.01 | -.04 | -.07 | -.04 | -.10 | +1.01 | +.02 | -.03 | -.41 | -.15 |
| Redbluff, Cal | -.07 | -.01 | .00 | .00 | .00 | .00 | +.05 | .00 | .00 | -.05 | +.04 | -.08 | -.21 | -.21 | +1.54 |
| Sacramento, Cal | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | -.03 | -.07 | -.01 | -.07 | -.14 | +.48 |
| San Francisco, Cal | -.02 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | -.01 | .00 | +.40 | -.09 | -.15 | +.44 |
| Los Angeles, Cal | -.02 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | .00 | -.03 | .00 | .00 | -.02 | -.07 | -.13 |
| San Diego, Cal | .00 | .00 | .00 | .00 | .00 | -.07 | .06 | .00 | .00 | .00 | .00 | .00 | -.06 | .00 | +.05 |

## THE PRINCIPAL INJURIOUS INSECTS OF THE YEAR 1900.

During the season of 1900 the most troublesome insects were the Hessian fly, green pea louse, apple louse, grain lice, San Jose scale, striped and twelve-spotted cucumber beetles, squash bug, cabbage worms of different species, various cutworms, and particularly the variegated cutworm, the Angoumois grain moth, plum curculio, oblique-banded and strawberry leaf-rollers and related forms, and flea-beetles of various species. The list which is furnished of species noted as injurious during the year is only a partial one, but is a fair indication of the more noteworthy occurrences of the season.

Roughly speaking, it may be said that such well-known forms as the fruit-tree bark-beetle, as well as most common species of fruit-tree borers, oyster-shell and other barklice, plum curculio, codling moth, and similar fruit species, the bean weevil, apple-tree tent caterpillar, and pine bark-beetles held their own as pests; while of insects that were noticeably less injurious than in most years may be mentioned such familiar species as the two tomato worms, the boll worm or corn-ear worm, harlequin cabbage bug, rose chafer, chinch bug, pear-tree psylla, army worm and fall army worm, bill bugs, melon louse, cabbage louse, and horn fly.

THE AMERICAN ELM SCALE (*Chionaspis americana* Johns.).—Was received at this office and was complained of as being more or less troublesome from New York, South Carolina, and Iowa. It appears to have attracted most attention in the first-mentioned State.

THE ANGOUMOIS GRAIN MOTH (*Sitotroga cerealella* Ol.).—This destructive granary pest was the cause of much injury to wheat and other grain stacked, mowed, and stored in the States of Pennsylvania, New York, New Jersey, and Massachusetts.

THE APPLE LOUSE (*Aphis mali* Fab.).—This well-known enemy of the apple was one of the worst pests of the year. It was unusually abundant in Maryland and Delaware, a common pest in Montana, and was reported as more or less destructive in the States of North Carolina, Virginia, Pennsylvania, Ohio, and Michigan.

THE BEAN LEAF-BEETLE (*Cerotoma trifurcata* Forst.).—Injury by this leaf-beetle was reported by Professor Johnson to wax and Lima beans throughout the trucking area of Maryland, and injury was also noted to beans by Mr. Chittenden and others in Maryland and Virginia, and was reported from North Carolina.

THE BLACK OR BROWN APHIS OF VIOLETS (*Rhopalosiphum violæ* Perg.).—Injuries to violets by this aphis were reported in Maryland and Rhode Island.

BLISTER BEETLES (*Epicauta pennsylvanica*, *E. cinerea*, *E. vittata*, and *Macrobasis unicolor*).—These and some other common species of blister beetles did the usual amount of injury to the potato and tomato crops over a wide extent of country, the first-mentioned being particularly troublesome to asters, zinnias, pinks, and other ornamental plants. Beets were also much affected by some of these species.

THE BOLL WORM OR CORN-EAR WORM (*Heliothis armiger* Hbn.).—This species, after a year of comparative rarity in Virginia, Maryland, and the District of Columbia northward, became quite numerous during the year 1900, doing considerable damage toward the close of the season to late corn, Lima beans, tomatoes, and other crops. Injuries were reported also from Georgia, Alabama, Mississippi, Rhode Island, and Pennsylvania.

THE BOX-ELDER PLANT-BUG (*Leptocoris trivittata* Say.).—During the season complaints were received of this species from North Dakota, where it was particularly troublesome, and from Washington and Wisconsin.

THE BRONZE APPLE-TREE WEEVIL (*Magdalis ænescens* Lec.).—This weevil, which has only recently been detected as an enemy to the fruit industry of the Pacific States, was again destructive as in the preceding years in the State of Washington.

THE CABBAGE LOOPER (*Plusia brassicæ* Riley).—After a year of extreme scarcity the cabbage looper returned to Maryland, Virginia, and the District of Columbia, and was the occasion of considerable injury to late cabbage, turnip, and other cruciferous crops. It was also destructive in Kansas, Texas, and Georgia.

THE CABBAGE PIONEA (*Pionea rimosalis* Guen.).—This species, like the preceding, returned to Maryland, Virginia, and the District of Columbia, and did considerable damage to cabbage and other cruciferous crops, beginning depredations in May. It was also reported to be destructive in Georgia. In 1899 it was not seen at all about the District of Columbia.

THE CIGARETTE BEETLE (*Lasioderma serricorne* Fab.).—This troublesome tobacco pest did as much injury during the past season as ever before in its history. Complaints were made of damage in different portions of the States of New York, Pennsylvania, Illinois, Ohio, and Maryland.

THE CLOVER LEAF WEEVIL (*Phytonomus punctatus* Fab.).—Was unusually abundant in Maryland, District of Columbia, and Ohio.

THE COLORADO POTATO BEETLE (*Doryphora 10-lineata* Say.).—This well-known potato pest was seriously injurious in Maryland and the District of Columbia, and injuries were reported also in Louisiana and New Jersey.

THE COMMON ASPARAGUS BEETLE (*Crioceris asparagi* Linn.).—Spread continued westward and northward in the States of New York, Pennsylvania, and Ohio, as well as in Canada. It was quite destructive in portions of Pennsylvania and Ohio.

THE COMMON BEAN WEEVIL (*Bruchus obtectus* Say.).—This bean weevil maintained its reputation as a pest during the year, seeming to be particularly destructive in the North. The States from which complaints were received include Vermont, Ohio, New Hampshire, Massachusetts, and Indiana.

THE COMMON SQUASH BUG (*Anasa tristis* De G.).—This bug was quite troublesome during the season in the States of Virginia, Maryland, Wisconsin, Pennsylvania, Nevada, California, and the District of Columbia.

THE DESTRUCTIVE GREEN PEA LOUSE (*Nectarophora destructor* Johns.).—This pernicious plant louse, which has only recently come to notice as a pest, attracted much attention, as it did in the preceding year along the Northern Atlantic section of our country, injury extending from North Carolina to Canada and westward in localities not infested previously as far as Wisconsin. Injury was particularly severe in Delaware, Virginia, Maryland, Ohio, North Carolina, Pennsylvania, Long Island, and elsewhere; in New York, Massachusetts, Illinois, New Jersey, District of Columbia, and Wisconsin, and was reported also in Vermont. Through the employment of remedies, chiefly what is known as the brush and cultivator method, much of the affected crops in Maryland and Delaware were saved. Still the loss along the Atlantic coast was estimated by Professor Johnson at $4,000,000.

THE EUROPEAN ORCHARD SCALE (*Aspidiotus ostreæformis* Curt.).—This imported scale is now known, from many localities in the country, from New York to California.

FORBES'S SCALE (*Aspidiotus forbesi* Johns.).—Received in many instances as injurious to peach and apple in the Eastern States, and caused serious damage also in Georgia, according to the report of Mr. Scott, entomologist of that State.

THE FOREST ARMY WORM, OR SO-CALLED FOREST TENT CATERPILLAR (*Clisiocampa disstria* Hbn.).—One of the destructive species of the season, but damage was not so severe as in the previous year. It did more or less injury in the States of Ohio, Texas, and New York, as well as in the District of Columbia, Oklahoma, and New Mexico, but injuries, by what was with little doubt the same species, were reported from a number of other States.

THE FRUIT-TREE BARK-BEETLE (*Scolytus rugulosus* Ratz.).—Injurious as in former years, and complaints were received of ravages from the States of Pennsylvania, New York, Missouri, Georgia, Kentucky, Tennessee, Massachusetts, and Michigan.

THE FRUIT-TREE LEAF-ROLLER (*Cacœcia argyrospila* Walk.).—This species was reported to have been concerned in injury to the foliage and fruit of apple and to the leaves of strawberry in Missouri and Indiana, and, according to Mr. Gillette, continued troublesome in Colorado, particularly in the vicinity of Denver and Boulder.

FULLER'S ROSE BEETLE (*Aramigus fulleri* Horn).—This rose beetle was reported to be destructive in lemon groves in southern California, as also in Hawaii.

THE GARDEN WEBWORM (*Loxostege similalis* Gn.).—Reported by Professor Morgan as a pest upon cotton and alfalfa in the northern portion of Louisiana and was found in the greatest abundance in the State of Arkansas. It returned to Maryland, near the District of Columbia, after an absence of a year.

THE GOOSEBERRY FRUIT WORM (*Zophodia grossulariæ* Pack.).—Reported by Mr. Cooley to have done much injury in Montana. The previous year it was destructive in Massachusetts.

THE GRAIN PLANT LICE (*Nectarophora granaria* Kirby and *Cerealis* Kalt.) were among the most important economic insects of the season, doing particular damage in Kansas, Nebraska, Oklahoma, South Dakota, and Illinois.

THE GRAPEVINE PHYLLOXERA (*Phylloxera vastatrix* Planch.).—The Phylloxera made its first appearance in the San Joaquin Valley, near Fresno, a great grape-growing district, and was reported also from New Jersey and Nebraska.

GREEN FRUIT-WORMS (*Xylina antennata et al.*).—Several species of green fruit-worms were reported to be destroying the foliage and fruit of apple, pear, peach, strawberry, and other plants in Missouri, Pennsylvania, and Indiana.

THE GREENHOUSE LEAF-TYER (*Phlyctænia rubigalis* Guen.).—This leaf-tyer was reported to be a serious pest in forcing houses in New York and in greenhouses in Canada during the season.

THE HARLEQUIN CABBAGE BUG (*Murgantia histrionica* Hahn).—This, one of our most important enemies to cruciferous garden crops, was abundant in certain few localities in Virginia, California, Maryland, and the District of Columbia, but was less injurious during the season in the northern portion of its range, as in the previous year, than for many years. It was stated to be uncommon in Delaware by Mr. Sanderson, and Professor Johnson reported that it was not injurious in any locality in Maryland known to him. In the Gulf States it was troublesome in Alabama.

THE HESSIAN FLY (*Cecidomyia destructor* Say).—One of the most destructive species of the year. It did great injury to early sown wheat in Maryland and to the wheat crop of Ohio. In the latter State damage was estimated at $16,800,000; over the greater part of the State of West Virginia also to wheat, and was very abundant in New York. Injury was also reported in the States of Indiana, Michigan, Tennessee, Kansas, Illinois, Virginia, North Carolina, and Pennsylvania.

THE HORN FLY (*Hæmatobia serrata* Rob.-Desv.).—This troublesome cattle pest was noted by Professor Cordley to have spread during the year to Oregon.

THE IMBRICATED SNOUT BEETLE (*Epicærus imbricatus* Say.).—This beetle was destructive to beans and canteloupes in Maryland and to fruit trees in Tennessee and Texas.

THE IMPORTED CABBAGE BUTTERFLY (*Pieris rapæ* Linn.).—Moderately destructive in Maryland, Virginia, and the District of Columbia. Complaints were also received from Utah, Illinois, and Georgia, but these reports do not give a fair example of the damage inflicted, as numerous inquiries for remedies for "cabbage worms," which, in most cases, referred with little doubt to this species, were received during the year, unaccompanied by specimens or descriptions from which the species concerned in the injury could be positively identified.

THE IMPORTED CABBAGE WEBWORM (*Hellula undalis* Fab.).—This imported webworm, a new and important insect foe to the cultivation of cruciferous crops, was reported during the year to have done injury in Georgia.

THE IMPORTED CURRANT WORM (*Pteronus ribesii* Scop.).—This currant worm was a serious pest in Maryland during the year. It was also complained of in the States of Missouri and Illinois.

THE MARGUERITE FLY (*Phytomyza chrysanthemi* Kowarz).—Responsible for much damage in the North in greenhouses, according to Professor Fernald.

THE MEDITERRANEAN FLOUR MOTH (*Ephestia kuehniella* Zell.).—This, our most pernicious mill pest, has continued its destructiveness in the State of Minnesota. Injury was reported by Professor Johnson also in the States of New York, Pennsylvania, Ohio, Oregon, and Texas, as well as in Canada and Australia.

THE MELON LOUSE (*Aphis gossypii* Glov.).—This plant-louse, which is usually destructive over a wide area, was not reported at this Department as doing much damage during the season, save in one locality in the State of Nebraska, the warm, dry weather during the greater part of the growing season being doubtless accountable for this condition.

THE MEXICAN BEAN WEEVIL (*Spermophagus pectoralis* Shp.).—An interesting occurrence of the year was that of this bean weevil, not known as a pest in the United States and not hitherto known in any of the countries recently coming under our control. It was found to be destroying beans at Havana, Cuba, and is probably well distributed on that island and perhaps in Porto Rico.

THE NEW PEACH SCALE (*Diaspis pentagona* Targ.).—This new scale is now known from several localities in Massachusetts, and has been received as injuring the peach in Alabama and Georgia, in the latter S'ate ranking, according to Scott, next in economic importance to the San Jose scale.

THE NORTHERN LEAF-FOOTED PLANT-BUG (*Leptoglossus oppositus* Say.).—Injury by this plant bug was noted during the season in Missouri, Arkansas, District of Columbia, and Virginia to the fruits of pear and other fruit trees, cantaloupes, and cymlings, and attack was noticed to ears of corn and the fruit of tomatoes.

THE OBLIQUE-BANDED LEAF-ROLLER (*Cacœcia rosaceana* Harr.).—This leaf roller continued injuries in Maryland, Virginia, and Canada, as reported in 1899, and was particularly destructive in the vicinity of Norfolk, Va., where it did great damage to strawberry, some fields being reported completely destroyed. More or less injury was also reported to apple in Missouri and Pennsylvania, in the latter State to foliage as well as to fruit, as also in Maine, Delaware, and the District of Columbia.

THE ONION THRIPS (*Thrips tabaci* Lind.).—Attack by this thrips was reported in Ohio and Minnesota.

THE OYSTER-SHELL BARK-LOUSE (*Mytilaspis pomorum* Bouché).—This scale insect, which is always destructive to apple, peach, and other fruit trees, was reported as causing more or less damage in the States of New York, Maryland, Arkansas, Missouri, Tennessee, New Jersey, Pennsylvania, South Carolina, Ohio, Rhode Island, Connecticut, Florida, Illinois, and the District of Columbia.

THE PALE-STRIPED FLEA BEETLE (*Systena blanda* Mels.).—This well-known flea beetle was the occasion of injury to beans in New York and Maryland and to sugar beets in Michigan and Colorado.

THE PALMER WORM (*Ypsolophus pometellus* Harris).—One of the most striking illustrations of the "ups and downs" of an insect's life occurred during the season in the case of the so-called palmer worm, which was seriously injurious to the foliage and young fruit of apple trees in central and western New York.

THE PEACH AND PLUM SCALE (*Lecanium nigrofasciatum* Perg.).—This pest, which has only been recently detected, was received during the year with complaints of more or less damage from Ohio, South Carolina, Texas, Mississippi, and Pennsylvania, being particularly numerous in the last-mentioned State.

THE PEA WEEVIL (*Bruchus pisorum* Linn.).—Doubtless owing to the ravages of the pea louse, the pea weevil, which has heretofore held first rank as an enemy to edible legumes, did not attract much attention. Injuries were reported, however, from the States of Virginia and Oregon.

THE PEACH TWIG BORER (*Anarsia lineatella* Zell.).—Reported to have done much injury to the new growth of peach trees in Colorado, and also some damage in New Mexico.

THE PERIODICAL CICADA OR SEVENTEEN-YEAR LOCUST (*Cicada septendecim* Linn.).—Brood XX was reported by Professor Webster to have appeared in abundance in parts of Ohio. From correspondence we learned of the occurrence of this species also in portions of the State of Pennsylvania, where it was quite generally distributed, as well as in New Jersey.

THE PLUM CURCULIO (*Conotrachelus nenuphar* Hbst.).—This well-known enemy of the plum and other fruit trees continued in normal abundance in most States, but was reported to be not quite as bad as usual in Maryland and Delaware. Complaints of injuries were received from Indiana, Virginia, Pennsylvania, New York, and Texas.

THE POTATO-STALK WEEVIL (*Trichobaris trinotata* Say.).—This stalk borer was injurious during the season to potato vines in Pennsylvania, and was reported as doing damage by Prof. Slingerland in Illinois and Professor Johnson in Maryland.

THE RASPBERRY SAWFLY (*Monophadnus rubi* Harr.).—The larva of this sawfly was the occasion of some injury to raspberry in Maryland, Illinois, and New York.

THE RED-HEADED FLEA-BEETLE (*Systena frontalis* Fab.).—This flea-beetle was destructive to sugar beets in the vicinity of Syracuse, N. Y.

THE ROSE CHAFER (*Macrodactylus subspinosus* Fab.).—This well-known enemy to rose and grape culture was reported as the cause of injuries in Ohio and New Hampshire, but was less numerous in Delaware and Maryland than usual.

THE SAN JOSE SCALE (*Aspidiotus perniciosus* Comst.).—Continued to be the most serious orchard pest in Maryland and New York; was reported as injurious in Rhode Island and Georgia. A list of other States from which injury was reported includes Virginia, Pennsylvania, West Virginia, California, Texas, New Jersey, Alabama, Louisiana, Michigan, North Carolina, Massachusetts, Mississippi, District of Columbia. The presence of the species was also noted by Mr. C. W. Mally at Cape Town, South Africa.

A SAWFLY ENEMY OF PLUM (*Lyda* sp.).—Reports were received from two localities in Missouri of injury to plums by the larva of a species of Lyda which as yet has not been identified.

THE SCULPTURED CORN BILL BUG (*Sphenophorus sculptilis* Uhl.).—Was reported to be ruining cornfields in Ohio. It was also destructive in Missouri and North Carolina.

THE SCURFY BARK LOUSE (*Chionaspis furfurus* Fitch.).—Continued to be one of the most common pests of apple and plum in the Northeastern States. It was found abundant also on plums in Georgia, as reported by Mr. Scott.

THE SEED-CORN MAGGOT (*Phorbia fusciceps* Zett.).—This maggot was the occasion of some trouble to young stalks of beans and peas in the District of Columbia and in Alabama.

THE SPINACH FLEA-BEETLE (*Disonycha xanthomelæna* Dalm.).—Beets growing in the District of Columbia were more seriously injured than ever noticed before in the history of this insect in the East.

THE SMARTWEED FLEA-BEETLE (*Systena hudsonias* Forst.).—Injury by this flea-beetle to beans was reported in New York.

THE SPOTTED CUTWORM (*Noctua c-nigrum* Linn.).—This was one of the most destructive cutworms of the year, injuries being noted in Maryland, Virginia, Indiana, Ohio, and Connecticut. In the last State it assumed what is known as the army-worm habit.

THE SOUTHERN LEAF-FOOTED PLANT-BUG (*Leptoglossus phyllopus* Linn.).—This plant-bug was injurious to Irish potatoes and spring wheat in Texas.

THE STRAWBERRY LEAF ROLLER (*Phoxopteris comptana* Frohl.).—This common pest was destructive to strawberry, raspberry, and blackberry in the District of Columbia, Maryland, and Virginia, as well as in portions of Massachusetts, Illinois, Iowa, Michigan, New Jersey, and Missouri.

THE STRAWBERRY ROOT-LOUSE (*Aphis forbesi* Weed.).—Cause of severe injury in Delaware, where it was given special study by Mr. Sanderson.

THE STRAWBERRY WEEVIL (*Anthonomus signatus* Say.).—Destructive to blackberry in Rhode Island, a State where injury has not previously been reported.

THE STRIPED CUCUMBER BEETLE (*Diabrotica vittata* Fab.).—This well-known enemy of cucurbits, a pest at all times, was particularly destructive during the past year in Maryland, District of Columbia, and certain parts of Colorado, as well as in Wisconsin, New York, and Iowa.

TOMATO AND TOBACCO WORMS (*Phlegethontius celeus* Say and *P. carolina* Linn.).—These two well-known "worms" did considerable damage to tomatoes in Maryland and Virginia, near the District of Columbia. Complaints were also received of injuries to either tomato or tobacco in the States of Ohio, New York, and New Jersey.

THE TOOTHED FLEA-BEETLE (*Chætocnema denticulata* O.).—This insect attracted attention from its attacks upon sweet corn in Maryland, near the District of Columbia.

THE TULIP TREE SCALE (*Lecanium tulipiferæ* Cook).—Numerous complaints were received of this species, especially from the State of Pennsylvania; also from New York, Virginia, Illinois, North Carolina, and Connecticut.

THE TWELVE-SPOTTED CUCUMBER BEETLE OR SOUTHERN CORN ROOT-WORM (*Diabrotica 12-punctata* Ol.).—This species is always the occasion of more or less damage, and the present year it was particularly abundant and injurious in Georgia and Alabama.

THE TWO-SPOTTED RED SPIDER (*Tetranychus bimaculatus* Harvey).—This destructive mite is always troublesome, particularly in greenhouses. During the season injuries were noted to be particularly serious in Illinois and the District of Columbia.

THE VARIEGATED CUTWORM (*Peridroma saucia* Hbn.).—During the season of 1900 this was the most troublesome of all the cutworms; in fact, one of the most destructive insects of the year and over a wide extent of territory, injuries, however, being most conspicuous in the Pacific States. Damage was especially severe in Washington and Oregon, and was reported also from Texas, Missouri, Kansas, Illinois, West Virginia, and California.

THE "WHITE FLY" OF THE ORANGE (*Aleyrodes citri* and *citrifolii*) did considerable damage, the first mentioned making its first appearance in southern California and greatly alarming the growers of citrus fruits. Injury by one or both of these species was noted in Alabama, Florida, North Carolina, as well as in California.

WHITE GRUBS AND MAY BEETLES (*Lachnosterna* spp.).—White grubs and their parents, the May and June beetles, were reported to have done more or less injury to shade, fruit, and nut trees in portions of the States of New York, Virginia, Connecticut, Kansas, North Carolina, Utah, Michigan, and Alabama.

WIREWORMS.—Various species of wireworms were the cause of injury in different States during the year, but only a few forms were given special study, and the species in most cases were not identified.

THE WOOLY MAPLE LOUSE (*Pemphigus acerifolii* Riley).—One of the most interesting occurrences of the year was that of this well-known plant-louse, which affects maple trees. It attracted special attention from the masses of downy secretion which envelops a colony of it and which appeared on shade trees in various places. It was the occasion of considerable alarm, which, however, was unfounded, as the species really does very little injury to the trees. Complaints were received from North Carolina, Virginia, Maryland, and Georgia.

## PLANT DISEASES IN THE UNITED STATES IN 1900.

In many parts of the country plant diseases were more than usually destructive in 1900. This was due in the case of some of the diseases of fruit trees to injuries sustained by them in the winter of 1898–99, and also to the excessive precipitation in certain parts of the country during the summer of 1900. In the New England States and part of the Middle States, as well as in the Dakotas and Minnesota, the season was drier than normal, and as a result the usual fungous diseases were not very abundant or destructive. On the other hand, throughout Georgia and Alabama and part of the Central States the precipitation was excessive, and as a consequence many diseases were very serious. To the warm winter of 1899–1900 may be attributed the almost total failure of the peach crop in southern California during the past season.

It was only through the hearty cooperation of the botanists of the various experiment stations with the Division of Vegetable Physiology and Pathology that it was possible to make the following brief notes.

### APPLES, PEARS, AND QUINCES.

Apples were affected by an unusually severe attack of bitter rot in a belt extending from the middle Atlantic States westward to Missouri and Kansas and thence southward to Texas. In parts of Missouri and Illinois, as well as in limited regions in the

Virginias, practically the whole crop was destroyed by this disease, either on the trees or in storage after picking. A conservative estimate places the loss caused to the apple industry of the United States by bitter rot at more than $10,000,000 for 1900 alone. Scab was prevalent over a large portion of the apple-growing region, being on the increase west of the Missouri River. It caused considerable damage in the States of Idaho and Washington. Where spraying was used, as recommended by this Department, the loss from scab was very light, the large losses being due to neglect of this important process. Apple rust also was locally destructive. In the north Pacific States black canker of the apple was still very destructive, being only partially under control.

Pears and apples and in some places quinces were very badly injured by pear blight in 1900. The disease was very destructive in Washington, Idaho, and Oregon, and in localities in California, States in which it has only been noticed for the past two or three years. It also caused a great deal of damage throughout the pear-growing regions of the South and to some extent in the apple-growing regions of the Central States. In Connecticut, where careful attention has been given to removing the diseased twigs, the disease was successfully checked. Pears and apples were locally affected by several other diseases, but none of enough importance to be mentioned.

### PEACHES AND PLUMS.

The brown rot of peaches and plums was one of the most destructive diseases of these fruits in 1900. The season was unusually humid over a large portion of the peach belt, and this caused the fungus to spread until it brought about nearly a total loss of the fruit in some regions. Most of the injury to the fruit occurred while it was still on the trees, but much was also destroyed during shipment. In Oregon and Washington the disease occurred to some extent, and it appeared for the first time in the San Francisco Bay region in California, but did not cause much injury there. The loss in the country as a whole amounted to several million dollars. Yellows was present in most of the peach regions of the Northern States east of the Mississippi River. It was unusually bad in Michigan and quite destructive in southern Illinois. Peach leaf curl was also of quite general distribution, although it was kept under control by the more thrifty growers, especially in California. The disease known as "little peach" continued to increase in western Michigan and threatens to prove very serious. It was also reported from western New York.

### GRAPES, ORANGES, OTHER FRUITS, AND WALNUTS.

Black rot and downy mildew were the only grape diseases of general importance in 1900, the latter being injurious to an extent worth mention only in some of the Gulf States. On the other hand black rot was very destructive in the lower Hudson River Valley in New York and from Maryland southward to the Gulf States, and also in Missouri and Tennessee. In most localities it was more destructive than in 1899, and in some cases did not yield to the ordinary spraying methods.

The raspberry and blackberry were both affected more or less by anthracnose and rust, while a disease of supposed bacterial nature caused considerable damage in Ohio and Illinois.

Leaf blight of the strawberry was the cause of considerable complaint from most of the regions where this fruit is grown on a large scale. However, improved methods of culture have reduced the losses from this disease very greatly.

In Florida pineapple blight caused about the same amount of injury as is usual every year. Oranges were quite seriously injured by sooty mold, which increased quite rapidly, following the spread of the white fly. Dieback was also quite prevalent, although it seems to be possible to combat it effectively by spraying with Bordeaux mixture. The same disease caused considerable loss in certain localities in California. In the latter State the bacterial diseases of walnuts is also on the increase and during the year occasioned very serious losses.

### POTATOES, SUGAR BEETS, MELONS, AND OTHER VEGETABLES.

Among field and garden crops the potato crop was destroyed or very badly injured in many localities in the Pacific coast States by late blight (*Phytopthora*). This disease was also prevalent to a lesser degree in some of the Atlantic States, and was also reported locally in the Lake region. For the rest of the country scab was the most injurious disease, although early blight (*Alternaria*) caused considerable loss, mainly in the inland States. These losses could have been very greatly reduced if the proper preventive measures had been taken.

Throughout almost the whole of the sugar-beet belt east of the Rocky Mountains, with the exception of a part of Michigan and of a few limited areas elsewhere, the crop was very seriously injured by the leaf spot disease. In many places the plants were killed outright, while everywhere the sugar content of the beet was greatly reduced, making its culture unprofitable in some localities. In California and inland, in the irrigated districts, immense damage was done by a combination of factors not yet well understood, but probably connected with the dry climate and irrigation.

Tomato culture was made unprofitable in many parts of the Southern States by the bacterial wilt, while in many of the Northern States the leaf spot disease caused considerable damage. In the irrigated districts, especially in Colorado and Utah, a great deal of complaint was made concerning a disease of tomatoes which seemed to be due to some unfavorable soil conditions.

Rust proved very destructive to asparagus in 1900. It appeared for the first time in several States, and now causes loss as far west as South Dakota, Nebraska, and Kansas. It destroyed nearly the entire asparagus crop on Long Island and was bad in the Atlantic coast States as far south as South Carolina.

Melons and cucumbers and other cucurbitaceous plants were badly injured in the North Central States by anthracnose. This disease was also present to a limited extent in Maryland and adjacent States. The downy mildew of muskmelons and cucumbers was pretty generally distributed throughout the eastern third of the country. In many parts of the North the growing of these plants under glass and also outdoors was entirely prevented. In parts of South Carolina and the adjacent States the growing of watermelons had to be abandoned, owing to the spread of the wilt disease.

A similar disease has made the growing of cabbages impossible in large areas of North and South Carolina, while in a few places in Maryland, New Jersey, and New York it is also found. Another wilt disease has proved destructive to flax in North Dakota, while still another has interfered with the growth of the cowpea in parts of South Carolina and other States.

### COTTON, CEREALS, FLAX, AND COWPEAS.

Of all the wilt diseases, that of cotton was of most importance; for it has been constantly spreading, and now occurs in spots over nearly the whole cotton-growing area of the South. It has practically prevented the growing of this crop in parts of the sea islands and uplands of South Carolina and also to some extent in Alabama. The production of resistant races has been shown by the Department to be possible, and promises to furnish a means of combating the disease. Besides the wilt, anthracnose has been destructive to cotton, especially in the Mississippi Valley region, while in Texas the root rot has occasioned immense loss. Cotton rust, which is dependent greatly upon weather conditions, was on the whole not more prevalent than usual.

The injury to cereals through rusts and smuts was in general about the same as in previous years. In North Carolina, however, wheat was unusually free from rust, while in Washington, on the other hand, the rusts were unusually severe, being especially destructive to the oat crop.

A wilt disease has proved destructive to flax in North Dakota, while still another has interfered with the growth of the cowpea in parts of South Carolina and other States.

## PROGRESS IN FRUIT GROWING IN 1900.

As in former years, much of the energy of the Division of Pomology has been directed toward the encouraging of the individual fruit grower in his efforts. This is especially true as relates to his ability to supply his own family wants. With this end in view two very important bulletins, one on the apple, the other on the grape, have been prepared and published during the past year. The demand for these, especially that on the apple, has been very great. These demands fairly indicate the growing desire for practical information on these subjects.

A largely increased number of new and promising varieties of fruits, especially of the apple, have been received at the Division of Pomology for examination and testing. Among these are some that give special promise. It is a generally established fact, based on long years of experience and observation, that varieties have their time limit of usefulness, a fact which gives zest to all efforts in the line of production of new and promising varieties. In addition to this the desire for the new and novel, only limited by skill and ability in production, is constantly leading experimenters onward in this line of work. In the past "chance" has had much to do with the production of varieties. The elements of certainty may ever be wanting, but the "chances" for definite and desirable results are now greatly increased. These facts are largely, if not wholly, due to the aid of science, which is now our chief reliance in plant breeding.

What was said last year in favor of thorough culture may be repeated with emphasis. Successful fruit growing, even in the favored climate of California, is not a matter that takes care of itself. Eternal vigilance is the watchword of all who succeed. The sluggard in Solomon's day was not known as a successful gardener, and conditions are not now greatly changed. This fact fully accounts for the great scarcity of thorough cultivators, who are always found in the "top story" of the business.

Washington claims to have shipped 1,000 carloads of apples the past season.

On December 1, 1900, there were in the various cold-storage establishments in this country an aggregate of 1,225,000 barrels of apples of the past year's crop.

Montana is rapidly developing into an apple-growing State. Apples grown there, as well as elsewhere in the Rocky Mountain region, are peculiarly bright colored and well developed.

A California authority advises local apple growers who pack for the export trade to be more careful in the handling of fruit. Poor prices for their fruit in the English markets prompt the advice.

An apple barrel has been invented with an expansive cushioned head which prevents bruising and also by its expansion keeps the barrel from becoming slack.

The apple succeeds throughout a wider range of territory than any other of the tree fruits. It is estimated that fully two-thirds of the settled area of the United States will produce the apple with varying degrees of success. The true apple belts, however, are becoming more clearly defined.

The National Apple Shippers' Association has recommended the general adoption of uniform packages for apples. This is a very important step in the right direction and will probably do more to hasten the desired result than anything short of statutory enactment.

The Georgia peach interest is rapidly growing into immense proportions. It is probable that more trees will be planted the coming spring than in any previous year.

Peach production will very surely be greatly stimulated by the successful efforts of the Department of Agriculture through Special Agent N. B. Pierce, of the Pacific Coast Laboratory, in the treatment of leaf curl.

California is said to have shipped about 250 carloads each of almonds and Persian walnuts last year.

Judging from the correspondence in the Division of Pomology there is a rapidly growing interest in nut culture. This is especially true of the pecan in the Gulf section and of the almond and Persian walnut in California.

Notwithstanding the repeated failures of Vinifera grapes within the United States east of the Rocky Mountains, the Division of Pomology is now conducting a series of experiments at Southern Pines, N. C., and Earleton, Fla., that promise good results. They are based on the idea that the numerous failures of the past are largely due to the work of phylloxera. Therefore these experiments are with Vinifera vines grown on resistant roots. During the past season a number of varieties have fruited, and the fruit has been tested at this office. Further time and tests will, however, be required before any definite results can safely be given out.

According to the Wisconsin Cranberry Growers' Association the crop of last year was the smallest since 1884, though yielding very satisfactory financial returns. The crop is set down at 189,000 barrels, 108,000 of which are credited to New York and New England, 63,000 to New Jersey, and 18,000 to the Western States.

Massachusetts (especially in the Cape Cod region), New Jersey, and Wisconsin are the cranberry-growing States of the Union. Many new varieties and new and improved methods of culture are being developed, and what was formerly a native wild plant is rapidly yielding to cultivation and domestication.

About 90 per cent of the raisins consumed in this country are claimed to be the output of California producers.

It is claimed that refrigeration of fresh fruits in storage and transit is slowly lessening the demand for evaporated and canned goods.

We are certainly approaching a period of general sanitary and quarantine regulations in the interests of fruit growing.

Massachusetts has enacted a law, now in effect, regulating the size of berry baskets. Other States (observing a uniformity in size) should follow.

Pacific coast prunes are now sold in large quantities in European markets, while importations from Turkey and other foreign countries that formerly supplied our markets are almost abandoned.

No fruit has yet been reported from the experiments (referred to in the last Yearbook) of Professor Webber, of the Division of Vegetable Physiology and Pathology, in producing hybrids of Citrus trifoliata and the sweet orange. His numerous plants, however, have made satisfactory growth, and are full of promise of good results in the near future. A well-known orange grower in Florida, who has charge of the experiments now being conducted, says, in a recent publication: "Out of fifty varieties there are several of great promise, although none of them have yet fruited. The inbred hardiness that comes from crossing with Citrus trifoliata is, however, already established."

The estimated consumption of oranges in the United States is 10,000,000 boxes. Of these, 6,200,000 are said to be grown in California, 800,000 in Florida, and 3,000,000 are imported.

The colony of blastophaga planted at Fresno, Cal., successfully passed the ordeal of their first winter on American soil and have since multiplied in a satisfactory manner. Dr. Howard, of the Division of Entomology, who has the experiment in charge, reports the production of many tons of Smyrna figs as the result of their friendly cooperation in the work of pollinizing the flowers of this excellent variety.

The highly creditable exhibition of fresh fruits, especially of the apple, made by the Department of Agriculture at the Paris Exposition has directed the attention of foreign markets to our resources in this line of production. This, in connection with the rapid developments in cold storage and refrigeration in transportation, will greatly extend and stimulate the production of market varieties.

## PROGRESS IN FORESTRY IN 1900.

What is conspicuous above all things else in the last year's developments is the growth and spread of popular interest in the questions which concern the country's forests and in forestry. This has come out most clearly in the correspondence of the Division of Forestry and of certain forestry associations, in experiences and conversations which those who are actively interested in forestry have had in all parts of the country, and especially in the public press. In the East and in California the interest has shown itself conspicuously in the activity of forest associations, and other organizations which have allied themselves with their work. Throughout the Rocky Mountain region there are few associations to give expression to this interest, but it has none the less made itself apparent in the tone of the press and in utterances at public meetings of various sorts. In the plains region the increasing interest has been notable.

The number of applications for planting plans and for working plans which have been received by the Department of Agriculture indicate the practical way in which the country is taking up forestry. That the interest has everywhere ceased to be chiefly sentimental is further shown by the number of students now registered in the three forest schools. At Cornell there are 24, 4 of them seniors; at Biltmore there are 9; at Yale, where the new forest school was started in October under the most favorable circumstances, with Prof. Henry S. Graves at its head and Prof. J. W. Toumey as assistant professor, there are 7.

The year's advance in forestry has taken place most conspicuously along two distinct lines. The first of these is that of the official work of the National Government; the second, that of the different State legislatures and bureaus of forestry.

The work of the National Government has consisted mainly of the mapping and care of the national forest reserves and in the application of well-considered methods of forest management to tracts of land held by private owners or State governments. The mapping of the reserves is of the first importance to their proper administration and should be completed as soon as possible. The forest division of the Geological Survey has, during the last year, issued full reports and maps covering the Pikes Peak, Plum Creek, South Platte, Battlement Mesa, and White River Plateau reserves, in Colorado; the San Gabriel, San Bernardino, and San Jacinto reserves, in southern California, and the Flathead and Bitter Root reserves, in Montana and Wyoming. Further statistics of the timber reserves of Washington have also appeared. Examinations and surveys of the forested and burnt-over lands of northern Minnesota have been completed, and reports will be published during the year 1901. The surveys of the Olympic Reserve have been finished, and the country between the Washington Reserve and the Mount Rainier Forest Reserve has been surveyed. The survey of the Sierra Reserve, in California, has been nearly finished. This year a step in the management of these reserves, which has long been hoped for, has also been taken. Hitherto the control of the national forests has been vested in the General Land Office, while all the trained foresters in the Government's employ have been in the Division of Forestry of the Department of Agriculture. The Secretary of the Interior has applied to the Department of Agriculture for working plans for the reserves, and has more lately signified his intention of placing the administration of these plans under the supervision of the Forester. This uniting of the work of the Division of Forestry and of the General Land Office will do much to close the fissure in the organization of the national forest work, which for two or three years has resulted only in waste of effort and opportunity.

The Division of Forestry, to be raised to the rank of a Bureau on July 1, 1901, carries on its roll so large a proportion of the men in America who are capable of doing forest work that to speak of what it has done is almost to say what has been done throughout the country. Chief among its undertakings have been the investigation of the grazing question on most of the forest reserves, the preparation of working plans for the Black Hills Forest Reserve, in South Dakota, and, in cooperation with the Forest, Fish, and Game Commission of New York State, for township 40 in the Adirondack Preserve—the tract containing the famous Raquette Lake. The applications for working plans on private holdings have reached a total of over 3,000,000 acres, and on about 175,000 acres working plans have already gone into operation. The advance in the practical application of forestry to American conditions thus indicated is a matter of congratulation for two reasons. It means that object lessons in forest management, which will appeal more strongly than could anything else to lumbermen, owners of wood lots, and State governments, are being established in different parts of the country. It also signifies that forestry is being fitted to American conditions, and that those who are practicing it in America are gaining the experience which will enable them to solve more and more of our difficulties and to get down to the terms which appeal to practical landowners.

The Division of Forestry has also been carrying on many lines of work which are more in the character of investigation, but of the results of which it will soon be possible to make practical use. Such are the examination of the effects of forest cover on the flow of the streams which was begun on the watershed of the Arrowhead Irrigation Company of southern California, and the investigations of the habits of reproduction and growth of such important lumber trees as the Red Fir of Washington and Oregon and the redwood of California.

For the fiscal year beginning July 1, 1901, the appropriation for forest work under the Department of Agriculture will be $187,240 instead of $88,520, as during last year. The fact that the division is being raised to the rank of a bureau is another sign of the increasing public recognition of the importance of its work.

In the different States forestry has progressed with varying speed. The excellent work of the forest commission in Michigan has resulted in a strong and interesting report, which will soon, no doubt, be followed by much-needed legislation; Wisconsin is beginning to follow Michigan's example; and in California, especially in the southern part of the State, where a steady water supply for purposes of irrigation is of vital importance, the people have been thoroughly stirred up about forest conservation and will no doubt soon formulate a plan for the protection of their forest resources. The appropriation by the State legislature for the purchase of the Redwoods in the Big Basin deserves notice. Forest laws have been passed by the State legislatures of Colorado, Pennsylvania, and some States in the Middle West. The Colorado law is aimed chiefly against fire and the cutting of forests where they are needed for the water supply. The Pennsylvania law establishes a "State Department of Forestry," and greatly strengthens the hands of the commissioner and his forest preserve board. Though other States have passed other laws, these are the most striking and worthy of notice.

To speak of what has been done by State and National Governments without calling attention to the rapidly increasing education of public opinion about forestry would be misleading. Before there are laws, forest preserves and parks, forest officers, and appropriations for them, there must be a widespread and vigorous public opinion with reference to forestry. Still more is this needed in order that holders of private property may be induced to consider the desirability of adopting conservative methods of forest management. In ways in which no Government bureau could do it, this necessary and very important work is carried on by such organizations as forestry associations. This has been notably the case in Minnesota, California, Indiana, Pennsylvania, Massachusetts, and New Hampshire. In these States there is an active local demand for good forestry. New Hampshire is the last State to have been stirred up, but it is taking hold with enthusiasm enough to make up for lost time. A great increase in the membership of the American Forestry Association is typical of this advance in public interest and in appreciation of forest work.

## DAIRY AWARDS FOR UNITED STATES AT PARIS EXPOSITION.

### DIPLOMAS OF THE GRAND PRIZE OF HONOR—6.

1. Borden's Condensed Milk Company, New York: For the "Eagle," "Peerless," and other brands of condensed milk.
2. Sam Haugdahl, New Sweden, Minn.: For creamery butter.

3, 4, 5, 6. The Secretary of the United States Department of Agriculture, Bureau of Animal Industry, Dairy Division, Washington, D. C.: For the collective exhibits of dairy products in the permanent exposition (June) and at the temporary dairy shows of May, July, and September.

DIPLOMAS OF THE GOLD MEDAL—38.

*a. For natural milk and cream:*
1. Briarcliff Farms, Briarcliff Manor, N. Y.
2. Fairfield Dairy Company, Montclair, N. J.
3. Stephen Francisco, Montclair, N. J.
4. H. B. Gurler, DeKalb, Ill.

*b. For condensed milk and cream:*
5. Pacific Creamery Company, Los Angeles, Cal.
6. St. Charles Condensing Company, St. Charles, Ill.

*c. For butter:*
7. Albert Lea Dairy Association, Albert Lea, Minn.
8. Briarcliff Farms, Briarcliff Manor, N. Y.
9. Cornish Creamery Company, Cornish Flat, N. H.
10. Deerfoot Farm Dairy, Southboro, Mass.
11. Hampton Cooperative Creamery Association, Easthampton, Mass.
12. Iowa Agricultural College Creamery, Ames, Iowa.
13. W. I. Noyes, Moland Cooperative Creamery Association, Moland, Minn.
14. Pine Tree Creamery Company, Sherman Mills, Me.
15. Simpson, McIntire & Co., Boston, Mass.
16. Aage Vind, Litchfield Creamery, Litchfield, Minn.

*d. For cheese:*
17. Ed Bissonette, Shoreham, Vt.
18. Chandler & Rudd Company, Cleveland, Ohio.
19. A. D. De Land, Sheboygan, Wis.
20. J. A. Ennison, Eldorado, Wis.
21. Milton Fassett, Martinsburg, N. Y.
22. W. A. Freeman, Gouverneur, N. Y.
23. J. F. Howard, Haverhill, Mass.
24. La Crosse Cheese Company, La Crosse, Wis.
25. A. F. MacLaren, Imperial Cheese Company, Detroit, Mich.
26. Edward Norton, Goshen, Conn.
27. Ohio State Dairy School, Columbus, Ohio.
28. Alvah L. Reynolds, New York, N. Y.
29. E. S. Rice, Triumph Dairy Company, Triumph, Ohio.
30. N. Simon & Co., Milwaukee, Wis.
31. C. E. Udell & Co., Chicago, Ill.
32. S. Underhill, New York, N. Y.
33. John Voght, Orihula, Wis.
34. Wisconsin State Dairy School, Madison, Wis.
35. New York State Paris Commission (collective).

*e. For by-products of dairying:*
36. J. H. Campbell, National Nutrient Company, Jersey City, N. J.
37. Casein Company of America, 74 John street, New York City.

*f. For collaboratory services:*
38. Raymond A. Pearson, assistant chief Dairy Division, United States Department of Agriculture.

DIPLOMAS OF THE SILVER MEDAL—52.

*a. For natural and sterilized milk and cream:*
1. H. B. Gurler, Clover Farm, DeKalb, Ill.
2. Russell Cream Company, San Francisco, Cal.

*b. For condensed milk and cream:*
3. Helvetia Milk Condensing Company, Highland, Ill.
4. Vermont Condensed Milk Company, Richmond, Vt.

*c. For butter:*
5. Armour & Co., Chicago, Ill.
6. Bark River Cheese Company, Hebron, Wis.
7. J. K. Bennett, Clinton Falls, Minn.
8. R. H. Bent, Adams, N. Y.

c. *For butter*—Continued.

9. Bridgewater Hills Creamery Company, Bridgewater, Conn.
10. John B. Candon, Pittsford, Vt.
11. Chesterfield Creamery Company, Chesterfield, Mich.
12. College Creamery, State Agricultural College, Ames, Iowa.
13. Dairymen's Union of California, San Francisco, Cal.
14. Elgin Creamery Company, Chicago, Ill.
15. Foster's Creamery Association, Frost, Minn.
16. Hoards' Creameries, Fort Atkinson, Wis.
17. La Belle Jersey Dairy, St. Charles, Minn.
18. Lagrange Creamery Company, Lagrange, Ga.
19. C. C. Lawless, Shady Rill Cooperative Creamery Company, Montpelier, Vt.
20. H. H. Leach, Upland Farm, North Brookfield, Mass.
21. Meridale Farms, Meredith, N. Y.
22. I. Walter Mitchener, Glen Hall, Pa.
23. Monadnock Farms, Monadnock, N. H.
24. Montague Cooperative Creamery Association, Montague, Mass.
25. Rockdale Creamery, Rockdale, N. Y.
26. Rosemary Creamery, Adams, N. Y.
27. W. D. Saunders, College Creamery, Blacksburg, Va.
28. Benj. Sharpless, West Chester, Pa.
29. Silver Lake Cooperative Creamery, Scandinavia, Wis.
30. Smith Creek Creamery (F. S. Rembe, maker), Vega, S. Dak.
31. H. T. Sondergaard, Litchfield Creamery, Litchfield, Minn.
32. M. Sondergaard, Casey, Minn.
33. South Platte Creameries, York, Nebr.
34. Wells River Creamery, Wells River, Vt.
35. Vernon Creamery Company, Rockville, Conn.

d. *For cheese:*

36. Rhodes Babcock, Chippewa Bay, N. Y.
37. F. X. Baumert, Antwerp, N. Y.
38. Beatrice Creamery Company, Lincoln, Nebr.
39. A. & H. E. Cook, Denmark, N. Y.
40. Dairymen's Union of California, San Francisco, Cal.
41. F. E. Dawley, Fayetteville, N. Y.
42. F. P. Dunaway, East Rodman, N. Y.
43. D. A. Goodrich, South Champion, N. Y.
44. W. W. Hall, Gouverneur, N. Y.
45. Fred Harvey, Gault, Cal.
46. Lewis Ladrach, Ragersville, Ohio.
47. Wm. A. Lawrence & Son, Chester, N. Y.
48. P. McDonough, Hinesburg, Vt.
49. Robert L. Norton & Co., Attica, N. Y.
50. Richardson, Beebe & Co., East Aurora, N. Y.
51. Jared Van Wagenen, jr., Hillside Farm, Lawyersville, N. Y.

e. *For by-products of dairying:*

52. The National Nutrient Company, 79 Hudson street, Jersey City, N. J.

### DIPLOMAS OF THE BRONZE MEDAL—28.

a. *For condensed milk:*

1. American Condensed Milk Company, San Francisco, Cal.
2. Maine Condensed Milk Company, Whitefield, N. H.
3. Pacific Coast Condensed Milk Company, Seattle, Wash.

b. *For butter:*

4. Wm. V. Beach, Charlotte, Vt.
5. Briarcliff Farms, Briarcliff Manor, N. Y.
6. Henry Eibert, Otisco, N. Y.
7. Elgin Creamery Company, Chicago, Ill.
8. Chas. W. Embich, Lancaster, Ohio.
9. H. J. Evans, Humboldt, Iowa.
10. Farmers' Cooperative Creamery Association, Collins, Iowa.
11. Franklin County Creamery Association, St. Albans, Vt.
12. Hoards' Creameries, Fort Atkinson, Wis.
13. Meridale Farms, Meredith, N. Y.
14. Mrs. J. R. Miller, Ryegate, Vt.
15. Monadnock Farms, Monadnock, N. H.

*c. For butter*—Continued.

16. Montague Cooperative Creamery Association, Montague, Mass.
17. Mrs. Carrie J. Nelson, Hillside Dairy Farm, Ryegate, Vt.
18. Oscar W. Reed, Lebanon Creamery, Lebanon, Ohio.
19. Mrs. C. H. Robbins, St. Charles, Minn.
20. Rosemary Creamery, Adams, N. Y.
21. Sanborn Creamery, Leavitts Hill, Deerfield, N. H.
22. Benjamin Sharpless, West Chester, Pa.
23. H. N. Slater, Fairmont, Minn.
24. Spring Brook Creamery Company, Chicago, Ill.
25. Vernon Creamery Company, Rockville, Conn.

*c. For cheese:*

26. F. X. Baumert, Antwerp, N. Y.
27. Lewis Ladrach, Ragersville, Ohio.
28. Alvah L. Reynolds, New York, N. Y.

## SCALE OF POINTS FOR JUDGING A DAIRY COW, REGARDLESS OF BREEDS.

In the accompanying illustration are indicated the parts of the cow taken into consideration in judging her merits as a dairy animal.

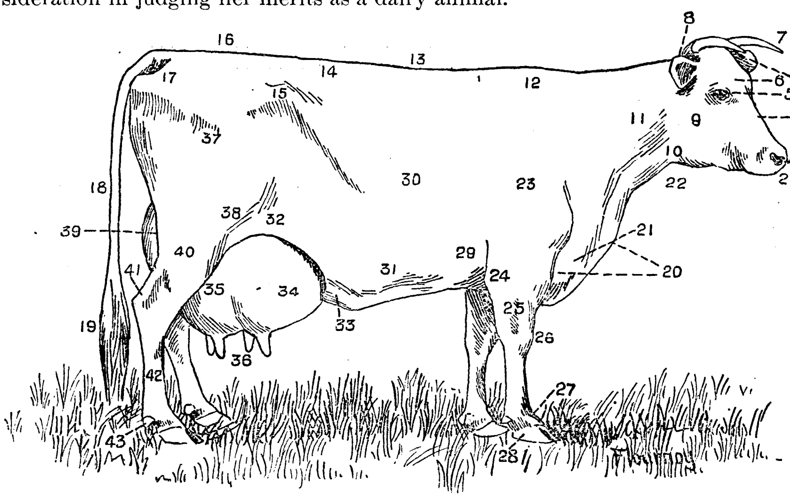


FIG. 88.—Diagram of cow showing points.

1. Head.
2. Muzzle.
3. Nostril.
4. Face.
5. Eye.
6. Forehead.
7. Horn.
8. Ear.
9. Cheek.
10. Throat.
11. Neck.
12. Withers.
13. Back.
14. Loins.
15. Hip bone.
16. Pelvic arch.
17. Rump.
18. Tail.
19. Switch.
20. Chest.
21. Brisket.
22. Dewlap.
23. Shoulder.
24. Elbow.
25. Forearm.
26. Knee.
27. Ankle.
28. Hoof.
29. Heart girth.
30. Side, or barrel.
31. Belly.
32. Flank.
33. Milk vein.
34. Fore udder.
35. Hind udder.
36. Teats.
37. Upper thigh.
38. Stifle.
39. Twist.
40. Leg, or gaskin.
41. Hock.
42. Shank.
43. Dew claw.

In judging dairy stock, 100 is assumed to represent the ideal or perfect dairy cow. The following is a list of the general qualities and particular parts considered, with the figures at the right indicating the "weight" or importance attached to each in making up the total of 100 points which stands for perfection:

GENERAL APPEARANCE:

*Constitutional vigor*, as shown by size, apparent health, strength, activity, and "general appearance" .............................................. 5

*Form*, wedge-shaped as viewed from front, side, and top................. 5

*Quality*, hair fine, soft; skin medium thickness, loose, mellow, and unctuous, with yellow secretion .......................................... 5

*Temperament*, active and nervous (but not "wild"), indicated by movements, eyes, and lean appearance.................................. 5

| | |
|---|---|
| HEAD AND NECK: | |
| *Forehead*, broad and full | 2 |
| *Horns*, small and fine, not too long, set well apart | 1 |
| *Eyes*, large, prominent, bright, and yet placid | 1 |
| *Face*, lean, not too short, straight or slightly dished | 1 |
| *Muzzle*, clean and strong, mouth and nostrils large | 1 |
| *Ears*, medium size, fine in texture, yellow secretion abundant | 1 |
| *Neck*, rather long and thin, fine; clean throat and light dewlap | 1 |
| FOREQUARTERS: | |
| *Chest* and *brisket*, broad and strong, low, but not too fleshy | 3 |
| *Withers*, well defined, firm, and lean | 1 |
| *Shoulders*, light, not fleshy, and oblique | 1 |
| *Legs*, straight, rather short, and not too large or coarse | 3 |
| BODY: | |
| *Back*, well defined, lean, open-jointed, not too level, and smooth; a good spine | 3 |
| *Barrel* or body, long and large; ribs broad, well arched, open, and well defined; a large, strong body | 8 |
| *Heart girth*, large and deep; abundant room for active heart and lungs | 4 |
| *Belly*, large, broad, and deep, with a large and strong navel | 6 |
| *Loin*, broad and strong | 3 |
| HINDQUARTERS: | |
| *Hips*, wide apart | 2 |
| *Pelvic arch*, prominent and strong | 3 |
| *Rump*, long and wide | 2 |
| *Tail*, long, fine, with a good switch | 1 |
| *Thighs*, long and lean, no beefiness; thin flanks | 3 |
| *Legs*, straight, rather short, wide apart, giving open twist, and not too large or coarse | 3 |
| *Fore udder*, full, broad, and extending well forward, not fleshy | 8 |
| *Hind udder*, broad, full, and attached high, not fleshy | 8 |
| *Teats*, of good size and form, evenly placed | 5 |
| *Milk veins*, upon the udder and in front of it, prominent, large, and tortuous, leading to large, open "milk wells" | 5 |

NOTES.—In scoring or marking, give to each part the number of points which it appears to deserve upon the scale given; use fractions of one-fourth if necessary. Thus if forehead is broad, full, and satisfactory, mark 2; if neck is short, thick, and beefy, mark ½ or ¼, or perhaps 0; if fore udder is deficient or defective, mark 6, 4, or 2, as the case may be. A good cow closely criticised and scored should have a total of 80 points or more.

## NUMBERS OF REGISTERED DAIRY CATTLE.

The following table shows the number of animals of each breed described in this bulletin which have been registered in the United States, and the estimated number of the same living in 1898:

*Number of animals registered in the United States, and estimated number of these living in 1898.*

| Breeds. | Number registered. | Number living. |
|---|---|---|
| Ayrshires | 22,000 | 6,050 |
| Brown Swiss | 2,871 | 1,250 |
| Devons | 18,343 | 10,000 |
| Dutch Belted | 1,128 | 500 |
| Guernseys | 16,600 | 11,000 |
| Holstein-Friesians | 100,000 | 60,000 |
| Jerseys | 184,000 | 90,000 |
| Polled Durhams | 1,321 | 1,200 |
| Red Polls | [1]19,068 | (?) |
| Shorthorns | 366,545 | 140,000 |
| Total | 731,876 | 320,000 |

[1]Includes all in Great Britain and United States.

## STATE STANDARDS FOR DAIRY PRODUCTS.

Standards for the composition of dairy products have been established in several States and are (in June, 1900) as follows:

| States. | Milk. | | | Skim milk. | Cream. | Butter. | Cheese. |
|---|---|---|---|---|---|---|---|
| | Total solids. | Solids not fat. | Fat. | Total solids. | Fat. | Fat. | Fat. |
| | *Per cent.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per cent.* | |
| California | | | | | | | Full cream, 30 p. ct. fat. Half skim, 15 p. ct. fat. Skim, from skim milk. (Fancy cheese excepted.) |
| Colorado | | | | | | | 35 p. ct. total solids to be fat. |
| District of Columbia | | 9 | 3.5 | 9.3 | 20 | 83 Not over 12 per ct. water or 5 p.c. salt. | |
| Georgia | | 8.5 | 3.5 | | | | |
| Illinois[1] | 12 | | 3 | | [2]15 | 80 | 48 p. ct. total solids, fat. |
| Indiana | | 9 | 3 | | | 80 | 10 p. ct. milk fats. |
| Iowa | 12.5 | | 3 | | 15 | Not over 15 per ct. water or 6 p.c. salt | |
| Maine | 12 | | 3 | | | | |
| Massachusetts | 13 | 9.3 | 3.7 | 9.3 | | | |
| *April-September* | 12 | 9 | 3 | | | | |
| Michigan | 12.5 Sp. grav. 1.029-33 | | 3 | sp. grav. 1.032-37 | | | |
| Minnesota | 13 | | 3.5 | | 20 | | 45 p. ct. total solids to be fat. |
| Missouri | | | | | | | From milk testing at least 3 p. ct. fat. |
| New Hampshire | 13 | | | | | | |
| New Jersey | 12 | | | | | | |
| New York[3] | 12 | | 3 | | | | Skim, from skim milk. |
| North Dakota | 12 | | 3 | | 15 | | Skim, from skim milk. |
| Ohio[3] | 12 | | 3 | | | 80 | 20 p. ct. fat. |
| *May and June* | 11.5 | | | | | | |
| Oregon[3] | 12 | 8 | 3 | sp. grav. 1.038 | 20 | Not over 14 per ct. water. | |
| Pennsylvania (Milk and skim-milk standards refer to cities of 2d and 3d class.) | 12.5 Sp. grav. 1.029-33 | | 3 | 2.5 p. c. fat. 6 per ct. cream by vol. sp. grav. 1.032-37 | | | Full cream, 32 p. ct. fat. Three-fourths cream, 24 p. ct. fat. One-half cream, 16 p. ct. fat. One-fourth cream, 8 p. ct. fat. Skim, below 8 p. ct. fat. (Fancy cheese weighing less than 5 pounds excepted.) |
| Rhode Island | 12 | | 2.5 | | | | |
| South Carolina | | 8.5 | 3 | | | | |
| Utah | | | | 9 per ct. solids not fat. | | | Skim, size regulated. |
| Vermont | 12.5 | 9.25 | | [4]4 | | | |
| *May and June* | 12 | | | | | | |
| Washington | | 8 | 3 | | 18 | | Full cream, 30 p. ct. fat. Skim, 15 per ct. fat. (Fancy cheese excepted.) |
| Wisconsin | | | 3 | | | | Skim, size regulated. |

[1] Condensed milk shall be made from milk containing at least the legal standard of 3 per cent butter fat and evaporated to one-third or less of its original volume.
[2] Coffee cream shall contain at least 15 per cent of fat, and whipping cream 22 per cent fat.
[3] Milk solids of condensed milk shall be in quantity the equivalent of 12 per cent of milk solids in crude milk, of which solids 25 per cent shall be fat.
[4] As basis for payment at factories.

## AGES AND PERIODS IMPORTANT IN BREEDING.

| Name of animal. | Age to begin breeding. | Periods of gestation and incubation. | Young at one birth; eggs for sitting. | Duration of œstrum. | Return for breeding after parturition. | Return to ascertain pregnancy. | Age of weaning. | Females to male. | Early age for market. | Usefulness for breeding. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Years.* | *Days.*[1] | *No.* | *Days.* | *Days.* | *Days.* | *Mos.* | *No.* | *Mos.* | *Years.* |
| Horse | 4 | 317, 342, 419 | 1 | 5 to 7 | 7 to 10 | 14 to 21 | 5 to 8 | 20 to 30 | 12 | 10 to 12 |
| Cow | 3 | 226, 280, 326 | 1 | 2 to 4 | 21 to 28 | 21 to 28 | 4 to 6 | 20 to 40 | 2 to 10 | 10 to 12 |
| Hog | 1 | 104, 120, 127 | 8 to 12 | 2 to 4 | 35 to 42 | 20 to 21 | 1½ to 2 | 6 to 10 | 10 | 6 |
| Sheep | 2 | 143, 151, 160 | 1 to 2 | 1 to 2 | 120 to 180 | 17 to 20 | 3½ to 4½ | 40 to 50 | 4 | 6 |
| Goat | 2 | 148, 155, 162 | 1 to 3 | (2) | (2) | (2) | (2) | 20 to 40 | 4 | 6 |
| Rabbit | ½ to 1 | 30 | 3 to 8 | | | | | 30 | | 5 to 8 |
| Hen[3] | 1 | 21 | 9 to 15 | | | | | 10 to 12 | 3 | 3 to 5 |
| Turkey | 1 | 28 | 9 to 15 | | | | | 6 to 8 | 8 | 10 |
| Guinea | 1 | 25 | 10 to 16 | | | | | 15 to 25 | | 10 |
| Duck | 1 | 28, 35 | 11 to 15 | | | | | 5 | 3 | 10 |
| Goose | 1 | 30, 35 | 7 to 10 | | | | | 5 | 3 | 10 |
| Pigeon[4] | ½ to 1 | 14, 18 | 2 | | | | | 1 | 1 | |
| Dog | 2 | 55, 63, 70 | 2 to 12 | | | | | | 3 | 8 |
| Cat | 1 | 48, 55, 60 | 3 to 6 | | | | | 5 to 6 | 3 | 6 |

[1] Varying figures show the shortest and longest periods and in most cases the average.
[2] Probably about the same as with sheep.
[3] The temperature for hatching eggs is 104° F.
[4] Pigeons hatch three to four broods in a season.

## PERIODS OF INCUBATION, OR LATENCY, OF DISEASE.

| | |
|---|---|
| Anthrax | ½ to 1 day |
| Canine distemper | 7 to 21 days |
| Cattle plague | 5 to 8 days |
| Contagious foot rot | 3 to 6 days |
| Foot and mouth disease | 2 to 4 days |
| Glanders and farcy | 7 to 42 days |
| Pleuro-pneumonia | 21 to 100 days or more |
| Rabies | 10 days to months |
| Tuberculosis | 14 to 60 days or more |
| Variola, cow | 6 to 9 days |
| Variola, horse | 6 to 8 days |
| Variola, sheep | 8 to 12 days |

## TEMPERATURE, PULSE, AND RESPIRATION OF DOMESTIC ANIMALS.

The artery usually selected for taking the pulse of the horse is the submaxillary, where it winds around the lower jawbone. On the inner side the artery may be readily felt and pressed against the bone, the number of beats in a minute, the regularity, and the strength are to be noticed as indicating the condition and action of the heart. In the cow the same artery should be felt, the precise location being at the lower edge of the flat muscle on the side of the cheek. When the cow is lying down the metacarpal artery on the back part of the fore fetlock may be felt conveniently.

For both horse and cow the temperature is taken by inserting a clinical thermometer in the rectum. Care should be taken that the mercury is below the normal temperature of the animal, and the thermometer should remain in the gut for three or four minutes.

The following table gives the normal temperatures, etc., of the principal domestic animals. The frequency of the pulse and of respiration even in repose depends somewhat upon the temperature of the air, stable, or house, and upon whether the observation is made before or after feeding.

*Normal temperature, pulse, and respiration.*

| Name of animal. | Internal temperature. | Number of pulsations. | Number of respirations. |
|---|---|---|---|
| | ° F. | *Per minute.* | *Per minute.* |
| Horse | 100.2 | 34 to 40 | 8 to 12 |
| Cow | 102.2 | 40 to 60 | 12 to 16 |
| Sheep and goat | 103.1 | 60 to 80 | 20 to 30 |
| Hog | 102.3 | 60 to 80 | 20 to 30 |
| Dog | 101.3 | 55 to 75 | 20 to 30 |
| Cat | 100.9 | 70 to 90 | 15 to 25 |

## EXTREMES OF TEMPERATURE SAFE FOR PERISHABLE GOODS.

| Perishable goods. | Lowest outside temperature. | | | Temperatures above which injury occurs. | Remarks. |
|---|---|---|---|---|---|
| | Articles in ordinary packages unprotected. | In ordinary freight cars. | In refrigerator or specially prepared cars. | | |
| | ° | ° | ° | ° | |
| Ale, ginger | 30 | 20 | −10 | ........ | |
| Apples, in barrels | 20 | 10 | −10 | 75 | Covered with straw. |
| Apples, loose | 28 | 15 | −10 | 75 | Packed in straw. |
| Apricots, baskets | 35 | 24 | 10 | 70 | |
| Aqua ammonia, barrels | 30 | 20 | −10 | ........ | |
| Asparagus | 28 | 22 | ........ | 70 | In boxes covered with moss. |
| Bananas | 50 | 32 | ........ | 90 | In bulk and in boxes with straw. |
| Beans, snap | 32 | 26 | ........ | 65 | In barrels or crates. |
| Bear | Zero. | −20 | ........ | 65 | Shipped loose. |
| Beef extract | 25 | 15 | −10 | ........ | |
| Beer or ale, kegs | 32 | 20 | Zero. | 75 | Packed in manure and shavings. |
| Beets | 26 | 20 | ........ | 70 | In crates. |
| Bluing | 30 | 20 | −10 | ........ | |
| Cabbage, early or late | 25 | 20 | Zero. | 75 | Barrels or crates. |
| Cantaloupes | 32 | 25 | 10 | 80 | |
| Carrots | 30 | 25 | 20 | ........ | |
| Catsup | 25 | 15 | −10 | ........ | |
| Cauliflower | 22 | 15 | ........ | 70 | In barrels with straw. |
| Celery | 10 | Zero. | ........ | 65 | Packed in crates. |
| Cheese | 30 | 25 | 10 | 75 | |
| Cider | 22 | 18 | −10 | 70 | |
| Clam broth and juice | 30 | 20 | −10 | 80 | |
| Clams, in shell | 20 | 10 | −10 | 65 | In barrels. |
| Cocoanuts | 30 | 20 | Zero. | 90 | In barrels or crates. |
| Crabs | 10 | Zero. | ........ | 65 | In baskets and barrels. |
| Cranberries | 28 | 20 | Zero. | ........ | |
| Cucumbers | 32 | 20 | ........ | 65 | In boxes with moss. |
| Cymlings, or squashes | 32 | 22 | ........ | 75 | In crates. |
| Deer | Zero. | −20 | ........ | 65 | Shipped loose. |
| Drugs (nonalcoholic) | 32 | 28 | Zero. | ........ | |
| Eggs, barreled or crated | 30 | 20 | Zero. | 80 | |
| Endive | 10 | Zero. | ........ | 70 | Packed in boxes or crates. |
| Extracts (flavoring) | 20 | 15 | Zero. | ........ | |
| Fish | 10 | Zero. | ........ | 65 | In barrels always iced. |
| Fish, canned | 18 | 15 | −10 | ........ | |
| Flowers | 35 | 20 | −10 | ........ | Packed in moss. |
| Grapes | 34 | 20 | Zero. | ........ | Packed in cork. |
| Grape fruit | 32 | 20 | Zero. | ........ | |
| Groceries, liquid | 32 | 20 | Zero. | ........ | |
| Ink | 20 | 15 | −10 | ........ | |
| Kale | 15 | Zero. | ........ | 65 | Packed in boxes or crates. |
| Leek | 28 | 20 | ........ | 65 | Packed in boxes. |
| Lemons | 32 | 20 | 10 | 75 | In boxes or crates. |
| Lettuce | 26 | 15 | ........ | 70 | Do. |
| Lobsters | 25 | 20 | Zero. | ........ | |
| Mandarins | 32 | 20 | Zero. | 75 | In boxes. |
| Medicines, patent | 32 | 28 | Zero. | ........ | Packed in sawdust. |
| Milk | 32 | 28 | Zero. | 75 | |
| Mucilage | 25 | 15 | Zero. | ........ | |
| Mustard, French | 26 | 20 | −10 | ........ | |
| Okra | 25 | 20 | ........ | 75 | In baskets or boxes. |
| Olives, in bulk | 28 | 25 | Zero. | ........ | In barrels. |
| Olives, in glass | 25 | 20 | Zero. | ........ | |
| Onions | 20 | 10 | Zero. | 80 | In barrels, boxes, or crates. |

**EXTREMES OF TEMPERATURE, ETC.**—Continued.

| Perishable goods. | Lowest outside temperature. Articles in ordinary packages unprotected. | In ordinary freight cars. | In refrigerator or specially prepared cars. | Temperatures above which injury occurs. | Remarks. |
|---|---|---|---|---|---|
| | ° | ° | ° | ° | |
| Oranges | 28 | 20 | Zero. | 80 | In baskets, boxes, barrels, or crates. |
| Oysters, in shell | 20 | 10 | −10 | 65 | In barrels. |
| Oysters, shucked | 30 | 20 | Zero. | 70 | Do. |
| Parsley | 32 | 20 | ........ | 75 | In baskets. |
| Parsnips | 32 | 20 | ........ | 70 | In baskets or barrels. |
| Partridges | 10 | Zero. | ........ | 65 | In bunches in boxes |
| Paste | 32 | 25 | 10 | ........ | In barrels. |
| Pears | 32 | 20 | 10 | 80 | |
| Peaches, fresh, baskets | 32 | 20 | 10 | 80 | |
| Peaches, canned | 20 | 15 | Zero. | ........ | |
| Peas | 32 | 20 | ........ | 80 | In baskets or barrels. |
| Pickles, in bulk | 22 | 18 | −10 | ........ | In barrels. |
| Pickles, in glass | 20 | 16 | −10 | ........ | |
| Pineapples | 32 | 25 | Zero. | 75 | In barrels, in crates, or in bulk. |
| Plums | 35 | 32 | Zero. | 75 | In boxes with paper. |
| Potatoes, Irish | 33 | 25 | 10 | 80 | In barrels or baskets. |
| Potatoes, sweet | 35 | 28 | 10 | 80 | Do. |
| Preserves | 20 | 10 | −10 | ........ | |
| Radishes | 20 | 15 | ........ | 65 | In baskets. |
| Rice | 20 | 10 | ........ | 90 | In barrels and sacks. |
| Shrubs, roses, or trees | 35 | 10 | −10 | ........ | In canvas or sacking. |
| Spinach | 15 | 15 | ........ | 75 | In barrels or crates. |
| Strawberries | 33 | 25 | −10 | 65 | |
| Tangerines | 25 | 15 | Zero. | 70 | In boxes. |
| Tea plants | 28 | 20 | ........ | 95 | Packed in boxes. |
| Thyme | 20 | 10 | ........ | 90 | In small baskets. |
| Tomatoes, fresh | 33 | 28 | 10 | 90 | |
| Tomatoes, canned | 28 | 25 | − 5 | ........ | In boxes. |
| Turnips, late | 15 | Zero. | ........ | 75 | In barrels. |
| Vinegar, barrels | 22 | 18 | −10 | ........ | |
| Watermelons | 20 | 10 | ........ | 85 | In barrels and in bulk. |
| Waters, mineral | 28 | 25 | Zero. | ........ | |
| Wines, light | 22 | 15 | Zero. | ........ | |
| Wild boar | Zero. | −20 | ........ | 65 | Shipped loose. |
| Wild turkey | Zero. | −20 | ........ | 65 | Do. |
| Yeast | 28 | 25 | Zero. | 65 | |

## RULES FOR NAMING AND EXHIBITING FRUITS.

The rules of the American Pomological Society for naming and exhibiting fruits are as follows:

### NAMING AND DESCRIBING NEW FRUITS.

*Rule 1.*—The originator or introducer (in the order named) has the prior right to bestow a name upon a new or unnamed fruit.

*Rule 2.*—The society reserves the right, in case of long, inappropriate, or otherwise objectionable names, to shorten, modify, or wholly change the same, when they shall occur in its discussions or reports; and also to recommend such changes for general adoption.

*Rule 3.*—The name of a fruit should preferably express, as far as practicable by a single word, a characteristic of the variety, the name of the originator, or the place of its origin. Under no ordinary circumstances should more than a single word be employed.

*Rule 4.*—Should the question of priority arise between different names for the same variety of fruit, other circumstances being equal, the name first publicly bestowed will be given precedence.

*Rule 5.*—To entitle a new fruit to the award or commendation of the society it must possess (at least for the locality for which it is recommended) some valuable or desirable quality, or combination of qualities, in a higher degree than any previously known variety of its class and season.

*Rule 6.*—A variety of fruit having been once exhibited, examined, and reported upon as a new fruit by a committee of the society will not thereafter be recognized as such, so far as subsequent reports are concerned.

COMPETITIVE EXHIBITS OF FRUITS.

*Rule 1.*—A plate of fruit must contain six specimens—no more, no less—except in the case of single varieties not included in collections.

*Rule 2.*—To insure examination by the proper committees all fruits must be correctly and distinctly labeled and placed upon the tables during the first day of the exhibition.

*Rule 3.*—The duplication of varieties in a collection will not be permitted.

*Rule 4.*—In all cases of fruits intended to be examined and reported by committees the name of the exhibitor, together with a complete list of the varieties exhibited by him, must be delivered to the secretary of the society on or before the first day of the exhibition.

*Rule 5.*—The exhibitor will receive from the secretary an entry card, which must be placed with the exhibit, when arranged for exhibition, for the guidance of committees.

*Rule 6.*—All articles placed upon the tables for exhibition must remain in charge of the society till the close of the exhibition, to be removed sooner only upon express permission of the person or persons in charge.

*Rule 7.*—Fruits or other articles intended for testing, or to be given away to visitors, spectators, or others, will be assigned a separate hall, room, or tent, in which they may be dispensed, at the pleasure of the exhibitor, who will not, however, be permitted to sell and deliver articles therein, nor to call attention to them in a boisterous or disorderly manner.

BASIS OF COMPARISON.

*Rule 1.*—In estimating the comparative values of collections of fruits, committees are instructed to base such estimates strictly upon the varieties in such collections which shall have been correctly named by the exhibitor prior to action thereon by the committee on nomenclature.

*Rule 2.*—In instituting such comparison of values, committees are instructed to consider: First, the values of the varieties for the purposes to which they may be adapted; second, the color, size, and evenness of the specimens; third, their freedom from the marks of insects and other blemishes; fourth, the apparent carefulness in handling and the taste displayed in the arrangement of the exhibit.

## THE COMPOSITION OF COMMERCIAL FOOD PRESERVATIVES.

In connection with the article on "The use and abuse of food preservatives," which appears on page 551 of the present Yearbook, a statement of the composition of those commercial preparations which have been examined is presented here. The list is arranged in the alphabetical order of the manufacturers. In each case reference is made to a footnote giving the name of the analyst and place of publication of the analysis.

It will be noticed that some preservatives have been examined by different analysts with widely varying results, indicating that the composition of some commercial preparations is not constant. One preservative was found to consist largely of salicylic acid in 1897 and of benzoic acid in 1900.

The wide spread use of these preparations is suggested by a case recently reported, where a preserving fluid had been added to milk first by the farmer, then by the collector to whom he sold, again by the wholesale dealer in the city, and finally by the retail dealer who delivered it to the consumer. The facts were developed by an investigation occasioned by the illness of children who drank the "doctored" milk.

The report upon all the preparations in this list is unfavorable. This, of course, does not mean that they are all dangerous poisons; it does mean that they are composed of substances which can not be recommended for general use in connection with human food. Some of them are quite hurtful and none should be used indiscriminately.

ADAMCZYK, BERLIN.—*Stabil (verbessertes Monopol).*[1] Percentage composition: Saltpeter, 79.6; salt, 10.1; sugar, 9.

ADAMCYZK, BERLIN.—*Probat.*[1] Percentage composition: Sodium sulphite, 47.50; sodium sulphate, 10.90; salt, 35.50; sugar, 4.5; iron oxid, lime, and water, 1.25.

H. BEHRND & CO.—*Carolin-Pulver.*[2] Percentage composition: Sodium sulphite, 47; sodium sulphate, 36; boric acid, 17.

E. J. BEGGS & CO., NEW YORK.—*Patent compressed antacid tablets.*[3] Salt, 44.76 per

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[1] E. Polenske, Arb. Kais. Ges. Amt., 1896, 12, 548.
[2] E. Polenske, Arb. Kais. Ges. Amt., 1898, 14, 684.
[3] Jenkins, Mitchell & Ogden, Report Conn. Agl. Expt. Station, 1899, Pt. II, p. 141.

cent; salicylic acid, 27.12 per cent, and sodium salicylate and carbonate in quantities not ascertained. Directions: A one-sixth ounce tablet for each one-eighth barrel of beer.

BLUE SEAL EXTRACT COMPANY, BOSTON, MASS.—*Blue Seal Preservative.* Two analyses. Boric acid, 29.76 per cent, and salicylic acid, 70.24 per cent;[1] boric acid, 42 per cent, and salicylic acid, 58 per cent.[2] Directions: From 2 to 4 ounces to 50 gallons of cider.

M. BROCKMANN, ENTRITZSCH, BEI LEIPSIG.—*Konservesalz.*[3] Percentage composition: Common salt, 34.32; saltpeter, 14.04; potassium sulphate, 15.00; borax, 24.86; boric acid, 12.

N. & J. BROWN, SPRINGFIELD, MASS.—*Cider and Wine Antiferment.*[2] The sample consisted of salicylic acid. Directions: One ounce to 30 or 40 gallons of wine or cider.

B. BURG, AGENT, KOPPENSTR. 30, BERLIN.—*Stuttgarter Konservirungsflüssigkeit für Fleisch*[4], (*Stuttgart Meat Preservative*). A yellow-colored liquid with an odor of sulphurous acid and a specific gravity of 1.075 at 16° C. Percentage composition: Salt, 0.55; normal calcium phosphate, 4.19; free phosphoric acid, 0.61; sulphurous acid, 3.74; arsenious acid, 0.01.

W. W. CHASE, NEWBURGH, N. Y.—*Antifermentine.*[2] Salicylic acid, 30 per cent; sodium salicylate, 70 per cent. Directions: One tablet (2.2 grains) to each pint of fruit.

DELVENDAHL & KÜNTZEL, BERLIN.—*Real Australian Meat Preserve.*[3] An aqueous solution containing 7.47 calcium bisulphite and 5.40 per cent free sulphurous acid.

DELVENDAHL & KÜNTZEL, BERLIN.—*Konzentrirt Berlinit.*[3] Percentage composition: Borax, 86.47; boric acid, 9.80; common salt, 7.46. This makes a total of 103.73 per cent, the excess being due to partial dehydration.

DELVENDAHL & KÜNTZEL, BERLIN.—*Berlinit Pöckel.*[3] Percentage composition: Common salt, 45.92; saltpeter, 32.20; boric acid, 19.16; water, 2.28.

WM. DOUGLAS & SONS, LONDON.—*Dry Antiseptic.*[2] Boric acid, 77.5 per cent, dry borax equivalent to 42.98 per cent of crystallized borax. Directions: One ounce to 10 pounds sausage or to 4 gallons milk.

E. DRESEL, BERLIN.—*Chromosot.*[5] Sample contains 90 per cent of a mixture of sodium sulphite and sodium sulphate and 8 per cent of albumen and coloring matter.

E. DRESEL, BERLIN.—*Konservirungs (pökel) salz.*[5] Percentage composition: Salt, 80; borax, 8; saltpeter, 12. To be used after mixing with 4 parts of salt.

E. DRESEL, BERLIN.—*Lakolin.*[6] (*Fleischerhaltungsessenz.*) Liquid, having a specific gravity of 1.244 at 15° C. A liter contains potassium sulphate, 6.8 grams; sodium sulphate, 17.6 grams; sodium bisulphite, 212 grams; sodium sulphite, 96 grams; boroglycerid, 31 grams; ferric chlorid, 3.6 grams.

E. DRESEL, BERLIN.—*Meat preserve krystall.* Percentage composition: Sodium sulphite, 53; sodium sulphate, 41; sodium chlorid, 6.[7] Second analysis: Sodium sulphite, 90; sodium sulphate, 10.[6]

E. DRESEL, BERLIN.—*Geruchlose meat preserve-flussigkeit.*[5] Specific gravity at 15°, 1.228. Percentage composition: Salt, 2.20; vanillin, 0.015; sodium sulphate, 7.35; sodium sulphite, 17.10; sodium bisulphite, 5.60; ferric chlorid, 0.3. Directions: Meat is washed with a bucketful of water containing one-half wine bottle full of the preservative or wrapped in cloth soaked in the same.

E. DRESEL, BERLIN.—*Meat preserve-pulver.*[5] The sample consisted of badly decomposed sodium bisulphite, containing 77 per cent of sodium sulphate. A bucketful of water containing a teaspoonful of the preservative is used for washing the meat or for soaking a cloth in which it is to be wrapped.

ADOLF DÜBECKE.—*Phlodarit, Neuestes Praservesalzfabrik der Magdeburger Konservesalzfabrik.*[6] Sodium sulphate, 75 per cent; sodium bisulphite, 25 per cent.

EDGEWOOD REFINING COMPANY, CLEVELAND, OHIO.—*Barnes's Liquid Extract of Hickory Smoke.*[2] Consists of pyroligneous acid.

ECKHADT, MUNICH.—*Konservesalz.*[8] Salt, 60 per cent; boric acid, 40 per cent.

CHARLES FRANKEN & BRO., NEW YORK, CHICAGO, AND KANSAS CITY. *XXXX Preservative.*[2] Sodium sulphite, 46 per cent, and sodium sulphate, 54 per cent. Directions: One ounce to from 35 to 40 pounds of chopped meat.

C. D. FORMAN, GENEVA, OHIO.—*Forman's Preservative for Wine.*[1] Solution containing 36.13 per cent formaldehyde.

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[1] Jenkins, Mitchell & Ogden, Report Conn. Agl. Expt. Station, 1899, Pt. II, p. 141.
[2] Unpublished results of Chemical Division, U. S. Department of Agriculture.
[3] E. Polenske, Arb. Kais. Ges. Amt., 1890, 6, 119.
[4] E. Polenske, Arb. Kais. Ges. Amt., 1889, 5, 364.
[5] E. Polenske, Arb. Kais. Ges. Amt., 1892, 8, 686.
[6] E. Polenske, Arb. Kais. Ges. Amt., 1892, 12, 256.
[7] Venzke & Schorer, D. Fleisch-Ztg., 21, Nos. 20, 21, and 24; abs. Chem. C. B., 1893, II, 1020.
[8] E. Polenske, Arb. Kais. Ges. Amt., 1896, 12, 548.

C. D. FORMAN, GENEVA, OHIO.—*Forman's Cider Preservative.* Alcoholic solution of beta naphthol, strength not given.[1] Second analysis: A 34 per cent solution of beta naphthol in alcohol.[2] Directions: Two fluid ounces to 45 gallons of cider, and 1½ ounces to 10 gallons of catsup.

GLASER & EHRLICH, BERLIN.—*Ohrtmann's Australian Salt.*[3] Percentage composition: Common salt, 5; borax, 95. The sample also contained about one-half per cent of a hydrocarbon whose odor resembled petroleum.

GEBR. GAUSE.—*Präservirungssalz.*[4] Percentage composition: Boric acid, 29.70; saltpeter, 37.80; salt, 26.70; water, 5.50.

ISAAK GOLDBERG, KASSEL.—*Excelsior,*[5] *Fleischerhaltungskrystal.* Percentage composition: Crystallized sodium sulphite, 85; crystallized sodium sulphate, 15.

OSKAR GUHARDT, LEIPZIG.—*Konservesalz.*[6] Percentage composition: Borax, 15; salt, 82; salicylic acid, 0.3; sodium and calcium sulphates, 2.7.

HAGENER KONSERVESALZ-FABRIK.—*Dreifaches Konservesalz.*[4] Percentage composition: Borax, 43.70; boric acid, 55.50; salt, 0.80.

HAGENER KONSERVESALZ-FABRIK.—*Einfache Konservesalz.*[4] Percentage composition: Borax, 35.25; saltpeter, 33.10; salt, 32.04.

OTTO HANN & BRO., 268 WATER STREET, NEW YORK.—*Preservit.* Contains over 96 per cent of benzoate of soda.[1] Sample consists of sodium benzoate.[7] Directions: Three ounces to a barrel of fruit juice and an additional 1.5 ounces when racked off in the spring.

L. A. HEISS, FRANKFORT.—*Dreifaches Konservesalz.*[6] The sample consists entirely of borax.

L. A. HEISS, FRANKFORT.—"*Frankfurter Konservesalz, Gloria.*"[6] Percentage composition: Salt, 86; saltpeter, 12; sodium and calcium sulphates, 2; colored with cochineal.

FRANK HELLWIG, BERLIN.—*The Real Australian Meat Preserve.* Colorless solution having a specific gravity of 1.038 at 20°. Percentage composition: Calcium oxide, 1.11; sulphur dioxide, 4.63.[4] Second analysis: Specific gravity, 1.0344; calcium oxide, 0.95; sulphur dioxide, 3.63; sulphuric acid, 0.30; solution of calcium sulphite and sulphurous acid.[3]

HELLER CHEMICAL CO., CHICAGO.—*Heinrich Meier's Carnaline Hamburger Konservirungs-salz.*[7] Percentage composition: Borax, 10; salt, 47; saltpeter, 24; colored with an aniline dye. Directions: From 2 to 4 ounces to 100 pounds of meat.

HELLER CHEMICAL CO., CHICAGO.—*Iceine.*[7] Contains from 55 to 60 per cent of sodium sulphite, the remainder being sodium sulphate. Directions: One ounce to 50 pounds of chopped meat.

HELLER CHEMICAL CO., CHICAGO.—*Iceline.* A 1.92 per cent solution of formaldehyde.[1] Second analysis: A 3.66 per cent solution of formaldehyde.[7] Directions: A tablespoonful to 10 gallons of milk; 1.5 to 2 times as much to cream and buttermilk. A tablespoonful to each gallon of cream intended for cream puffs.

B. HELLER & CO., CHICAGO.—*Rudolf Gebhard's Red Berliner Konservirungssalze.*[7] The sample contained borax, salt, and saltpeter in quantities not determined and was colored with an aniline dye. Directions: Four ounces to be added to curing brine for each 100 pounds of meat.

B. HELLER & CO., CHICAGO.—*Rudolf Gebhard's Rosaline Berliner Konservirungssalze.*[7] Percentage composition: Borax, 24; salt, 48; saltpeter, 27; colored with an aniline dye. Directions: From 2 to 4 ounces to 100 pounds chopped meat.

B. HELLER & CO., CHICAGO.—*Rudolf Gebhard's White Berliner Konservirungssalze.*[7] Percentage composition: Boric acid, 59; salt, 41. Directions: From 2 to 4 ounces to 100 pounds of chopped meat, or meat may be dipped in a solution of 1 pound to 1 gallon of water.

B. HELLER & CO., CHICAGO.—*Freeze-em.* Percentage composition: Sodium sulphate, 34.19; sodium sulphite, 57.48; salt, 2.18. Contains 29.19 per cent sulphurous acid.[1] Second analysis: Five samples show from 57 to 66 per cent of sodium sulphite.[7] Third analysis: Sample consists of dry sodium sulphite of which 15.6 per cent has changed to sulphate. Traces of salt and sodium carbonate are also present.[8] Directions: One ounce to 50 pounds of chopped meat.

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[1] Jenkins, Mitchell & Ogden, Report Conn. Agl. Expt. Station, 1899, Pt. II, p. 141.
[2] Duncan Stewart, Vermont Agl. Expt. Station, 1895, 355.
[3] E. Polenske, Arb. Kais. Ges. Amt., 1890, 6, 119.
[4] E. Polenske, Arb. Kais. Ges. Amt., 1889, 5, 364.
[5] Venzke & Schorer, D. Fleisch-Ztg., 21, Nos. 20, 21, and 24; abs. Chem. C. B., 1893, II, 1020.
[6] E. Polenske, Arb. Kais. Ges. Amt., 1896, 12,548.
[7] Unpublished results of Chemical Division, U. S. Department of Agriculture.
[8] E. Polenske, Arb. Kais. Ges. Amt., 1899, 15, 365.

B. Heller & Co.. Chicago.—*Freezine.* Liquid containing 5.19 per cent formaldehyde.[1] Second analysis: Liquid containing 2.52 per cent formaldehyde.[2] Directions: One tablespoonful to 10 gallons of milk, 6⅝ gallons of cream or buttermilk, or 3½ gallons of ice cream; one teaspoonful to each gallon of cream intended for cream puffs.

B. Heller & Co., Chicago.—*Zanzibar Carbon*[2] and [3]. Sample contains 75 per cent of salt and 25 per cent of an aniline dye which was found to be Bismarck brown. It also contains a small amount of a volatile oil and has a smoky odor.

Theodore Heydrich & Co., Wittenberg.—*The Real American Meat Preserve.*[4] A solution containing 200 grams crystallized sodium sulphite and 75 grams sodium sulphate per liter.

Theodore Heydrich & Co., Wittenberg.—*Einfaches Konservesalz.*[5] Percentage composition: Salt, 73.40; saltpeter, 15.50; boric acid, 9.45; water, 1.23.

Theodore Heydrich & Co., Wittenberg.—*Einfaches Konservesalz* (*Rötendes Pökelsalz*).[4] Percentage composition: Salt, 62; sodium bicarbonate, 4; sodium nitrate, 34.

Theodore Heydrich & Co., Wittenberg.—*Dreifaches Konservesalz,* or *Erhaltungspulver.*[5] This preservative consists entirely of boric acid.

Humiston & Co., New Haven, Conn.—*Rex Magnus. Snow Flake Brand.*[1] Sample contained 12.06 per cent salt and the equivalent of 78.15 per cent boric acid, of which about 35 per cent is free and the rest in the form of borax.

Humiston & Co., New Haven, Conn.—*Rex Magnus. The Ocean Wave Brand.* For oysters, clams, and sea food generally. The sample contained 9.71 per cent of salt and 88.85 per cent boric acid, part of which was combined as borax.

Humiston & Co., New Haven, Conn.—*Rex Magnus. Pearl Brand or Cream Preservative.*[1] Percentage composition: Salt, 8.22; boric acid (partially combined), 95.72.

Humiston & Co., New Haven, Conn.—*Rex Magnus. Preservative for sausage.*[1] Percentage composition: Sodium sulphate, 2; sodium sulphite, 6.55; sodium bicarbonate, 21.03; salt, 40.06; other matters not determined, chiefly water, 30.36. Directions: One pound to 100 pounds of sausage meat.

Humiston & Co., New Haven, Conn.—*Rex Magnus. The Sportsman's Rex.*[1] Salt, 19.61 per cent; boric acid, partly combined as borax, 81.77 per cent. Directions: Sprinkle drawn game inside and out, wrap in cloths soaked in solution, or soak in solution of 1 pound in 2 gallons of water.

Humiston & Co., New Haven, Conn.—*Rex Magnus. Viandine Brand.*[1] Identical with the Sportsman's Rex.

Hugo Jannasch, Bernburg.—*Patentirtes Konservesalz.*[4] Borax, 60 per cent; salt, 40 per cent.

Louis Kahn, Hamburg.—*The Real Australian Meat Preserve.*[4] A solution of calcium bisulphite containing 5.92 per cent of sulphurous acid.

E. Krauser & Bro., Milton, Pa.—*Liquid Extract of Smoke.*[2] Consists of pyroligneous acid. Directions: To be applied to surface of meat with brush or cloth.

Konservesalzfabrik, Stuttgart.—*Dreifaches Konservesalz.*[4] Borax, 82; nitrate of soda, 18.

Konservesalzfabric, Stuttgart.—*Einfaches Konservesalz.*[4] Percentage composition: Salt, 51; nitrate of soda, 42; borax, 7.

Robt. Kuhlrott, Leinefelde.—*Dreifaches Konservesalz.*[4] Percentage composition: Boric acid, 93.5; saltpeter, 5; sodium chlorid and sulphate, 1.5.

Robt. Kuhlrott, Leinefelde.—*Einfaches Konservesalz.*[4] Percentage composition Saltpeter, 48; boric acid, 50; sodium chlorid and sulphate, 2.

E. Kuhlmann, Berlin.—*Starkwirkendes Konservesalz.*[4] Equal parts of boric acid and salt.

E. Kuhlmann, Berlin.—*Fleisch-Konserve-Fluidum.*[4] A solution containing 5.5 per cent of calcium bisulphite and 0.5 per cent of free sulphurous acid.

E. Kuhlmann, Berlin.—*II Pökelkonservesalz.*[4] Percentage composition: Salt, 66; saltpeter, 17; borax, 17.

G. Langheim & Co.—*Konservirungs-salz.*[6] Percentage composition: Crystallized sodium sulphite, 80; crystallized sodium sulphate, 20.

R. Liefenthal, Cologne.—"*Röthend*" *Präservirungsalz.*[7] Percentage composition: Boric acid, 28.34; salt, 9.58; saltpeter, 9.58; water, 4.50.

R. Liefenthal, Cologne.—"*Nicht röthend*" *Präservirungsalz.*[7] Percentage composition: Borax, 87.40; salt, 3.44; sodium bicarbonate, 9.10.

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[1] Jenkins, Mitchell & Ogden, Report Conn. Agl. Expt. Station, 1899, Pt. II, p. 141.
[2] Unpublished results of Chemical Division, U. S. Department of Agriculture.
[3] E. Polenske, Arb. Kais. Ges. Amt., 1899, 15, 365.
[4] E. Polenske, Arb. Kais. Ges. Amt., 1896, 12, 548.
[5] E. Polenske, Arb. Kais. Ges. Amt., 1890, 6, 119.
[6] E. Polenske, Arb. Kais. Ges. Amt., 1894, 10, 508.
[7] E. Polenske, Arb. Kais. Ges. Amt., 1889, 5, 364.

MASS & WALDSTEIN, NEW YORK.—*Preserving salts.*[1] Six samples, Nos. 1 to 6, inclusive, are offered for different classes of foods and sold at different prices, but are identical in composition. They contain about 30 per cent of borax and 10 per cent of salt. Directions: From 3 to 4 ounces to 100 pounds of food.

G. MOERIËS, MAGDEBURG.—*Magdeburger Konservesalz.*[2] Percentage composition: Common salt, 20.42; borax, 28.35; boric acid, 59.21. This makes a total of 107.98 per cent, the excess being due to partial dehydration.

NEW YORK MALT ROASTING COMPANY, EMKEN CHEMICAL COMPANY, PROP.—*Emken's Preserving Cakes No. —.*[1] 22.09 per cent free salicylic acid, cane sugar, considerable quantity of salicylate of soda, small quantity of magnesia and sulphates.

F. NIETSCH, FRIEDRICHSTR. 245, BERLIN.—*Amerikanische Schinken-präserve (American ham preservative)*.[3] A yellow-colored liquid, with empyromatic odor, resembling tar water, and having a specific gravity of 1.049 at 16°. It contained 7 per cent of alum and 2.14 per cent of saltpeter.

ZANE NORNY & CO., PHILADELPHIA, PA.—*Norny's Fruit Preserving Powder.*[4] Sample contained 53 per cent of calcium sulphite, the remainder being calcium sulphate.

S. OPPENHEIMER, NEW YORK.—*Superior Preserving Powder.*[4] Percentage composition: Borax, 34; salt, 42; saltpeter, 21. Colored with aniline dye.

PRESERVALINE MANUFACTURING COMPANY, NEW YORK.—*"A" Preservaline.* Percentage composition: Borax, 68; salt, 32.[1] Second analysis: Borax, 75; salt, 19.[4] Directions: Mixone-half pound with 150 pounds of chopped meat; dust 1 pound over 500 pounds of fresh meat; immerse poultry, drawn or undrawn, in a solution of one-quarter pound in 2 gallons of water for ten minutes.

PRESERVALINE MANUFACTURING COMPANY.—*"B" Preservaline.*[4] Percentage composition: Borax, 36; salt, 46; saltpeter, 18; colored with an aniline dye. Directions: One-half pound to 100 pounds of sausage meat.

PRESERVALINE MANUFACTURING COMPANY.—*"B B" Preservaline.*[1] 32.56 per cent salt and rest consists of boric acid and borax, equivalent to 65.42 per cent boric acid.

PRESERVALINE MANUFACTURING COMPANY.—*"B P" Preservaline.*[4] Ammonium fluorid. Directions: One pound to from 200 to 250 barrels of beer.

PRESERVALINE MANUFACTURING COMPANY.—*Bleachine.*[4] Identical with lard bleacher, but sold for 25 cents a pound.

PRESERVALINE MANUFACTURING COMPANY.—*"C" Preservaline.*[4] Percentage composition: Borax, 21; boric acid, 11; salt, 32; saltpeter, 21. Directions: One-half pound to 4 to 6 gallons pickle or to 100 pounds of meat.

PRESERVALINE MANUFACTURING COMPANY—*"C C" Preservaline.*[4] The sample contained the equivalent of 79 per cent of boric acid and 43 per cent of salt.

PRESERVALINE MANUFACTURING COMPANY.—*Preservaline for Cider.* Sample consisted of salicylic acid.[1] Sample consisted of sodium benzoate.[4] Directions: From 2½ to 3 ounces to a barrel of 45 to 50 gallons.

PRESERVALINE MANUFACTURING COMPANY.—*Special Cider Preservaline.*[4] A 22 per cent solution of sodium benzoate in water.

PRESERVALINE MANUFACTURING COMPANY.—*Clam Preservaline.*[4] A mixture of 2 parts borax and 1 part salt.

PRESERVALINE MANUFACTURING COMPANY.—*Cod Preservaline.*[4] Percentage composition: Borax, 53; boric acid, 27; salt, 32.

PRESERVALINE MANUFACTURING COMPANY.—*Composite test, Preservaline No. 2.*[5] A 10 per cent solution of formaldehyde.

PRESERVALINE MANUFACTURING COMPANY.—*Crab-meat Preservaline.*[4] Identical with Clam Preservaline.

PRESERVALINE MANUFACTURING COMPANY.—*Cream Albuminoid.*[1] 50.4 per cent boric acid, mixed with some proteid body, apparently gelatine.

PRESERVALINE MANUFACTURING COMPANY.—*"F F" Preservaline.*[4] Identical with Cod Preservaline.

PRESERVALINE MANUFACTURING COMPANY.—*"F F" Extra Preservaline.*[4] Identical with Cod Preservaline.

PRESERVALINE MANUFACTURING COMPANY.—*"L" Preservaline.*[4] Identical with Clam Preservaline.

PRESERVALINE MANUFACTURING COMPANY.—*Lard Bleacher.*[4] The sample consisted entirely of borax.

PRESERVALINE MANUFACTURING COMPANY.—*"M." Preservaline.*[4] The equivalent of 97.81 per cent boric acid, with 2 per cent of other matters, chiefly soda.[1] Apparently borax.[5]

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[1] Jenkins, Mitchell & Ogden, Report Conn. Agl. Expt. Station, 1899, Pt. II, p. 141.
[2] E. Polenske, Arb. Kais. Ges. Amt., 1890, 6, 119.
[3] E. Polenske, Arb. Kais. Ges. Amt., 1889, 5, 364.
[4] Unpublished results of Chemical Division, U. S. Department of Agriculture.
[5] Duncan Stewart, Vermont Agl. Expt. Station, 1898, 355.

Preservaline Manufacturing Company.—*No ice needed "M" Preservaline.*[1] A 4 per cent solution of formaldehyde.

Preservaline Manufacturing Company.—*Special "M." Preservaline.*[2] Solution containing 1.99 per cent formaldehyde.

Preservaline Manufacturing Company.—*Patent "M" Preservaline.*[3] The sample contained 83 per cent of boric acid and 17 per cent of borax.

Preservaline Manufacturing Company.—*Milk Sweet.* A 3.90 per cent solution of formaldehyde.[3] A 10 per cent solution of formaldehyde.[1]

Preservaline Manufacturing Company.—*Shrimp Preservaline.*[3] Identical with Cod Preservaline.

Preservaline Manufacturing Company.—*Sportsmen's Preservaline.*[3] Identical with Cod Preservaline.

Preservaline Manufacturing Company.—"*XXX*" *Preservaline.*[3] Sodium sulphite, 88 per cent; sodium sulphate, 12 per cent. Directions: One ounce to 50 pounds of chopped meat.

Preservaline Manufacturing Company.—*Special Preservaline No. 5.* A solution containing 12 per cent of borax and — ammonium fluorid in quantities not determined.[3]

Preservaline Manufacturing Company.—*Special Preservaline No. 14.*[3] Sample consisted of sodium benzoate and is identical with Preservaline for cider.

H. Reich, Magdeburg.—*Australian Salt.*[4] Percentage composition: Salt, 50; saltpeter, 25; sugar, 25.

H. Reich, Magdeburg.—*Australian Salt I.*[5] Percentage composition: Salt, 50; borax, 25; saltpeter, 25.

H. Reich, Magdeburg.—*Australian Salt II.*[5] Equal parts of boric acid and salt.

J. R. Rockwell & Co., Jackson, Mich.—*American Woman's Standard Canning Process.*[3] Salicylic acid and sodium salicylate in equal parts.

H. L. Rose, Hamburg.—*Antisepticum.*[6] Commercial boric acid.

H. L. Rose, Hamburg.—*Roseline.*[6] A deep red liquid. A bottle of 850 cc. contained 20 grams of boric acid and 24.86 grams of carmine lake. There was 18.6 grams of insoluble material, with 1.26 grams of ash.

H. L. Rose, Hamburg.—*Schwefelpräparat.*[6] A strip of pasteboard 4 by 22 cm., covered with about 30 grams of sulphur.

H. L. Rose, Hamburg.—*Konservesalz.*[5] Boric acid, 95 per cent; sugar, 5 per cent.

Ch. Rothkrämer & Son, Erfurt.—*Boroglycin.*[5] Boric acid, 95 per cent; sugar, 5 per cent.

C. Schmidt & Co., Cincinnati.—*Nonpareil Preservative No. 1.*[3] Percentage composition: Borax, 55; salt, 27; saltpeter, 18.

C. Schmidt & Co., Cincinnati.—*Nonpareil Preservative No. 2.*[3] Percentage composition: Borax, 28; salt, 29; saltpeter, 32.

Rudolph Schneider, New York.—*K. M. S. Compressed Preserving Powders.*[2] Sodium sulphate (anhydrous), 16.61 per cent; sodium bisulphite, 25.47; sugar, 48.

H. Schramm & Co., Berlin.—*Neuestes Fleischpreserve-Pulver.*[7] A badly decomposed sample of sodium bisulphite. Percentage composition: Sodium bisulphite, 57; sodium sulphate, 43.

D. F. Schull & Co., Philadelphia, Pa.—*Ozone Antiseptic Compound.*[3] The sample contained 51 per cent of boric acid and 72 per cent of borax, the high total (123) being due to partial dehydration. Directions: A tablespoonful to 20 or 30 quarts of milk or 10 pounds of butter or cheese.

Louis Schult, Berlin.—*Minerva (china erhaltungspulver).*[8] Percentage composition: Common salt, 25; boric acid, 17.70; sodium sulphate, 38.84; sodium sulphite, 9.20; water, 9.40.

Fr. M. Schultz, Berlin.—*Sozolith, Koncentrirtes Fleisch-Preservesalz.* (*Concentrated meat preservative*).[8] The sample contains 37.27 per cent of sodium sulphate and 62.73 per cent of sodium sulphite. The sulphurous acid content was 39.68 per cent.

J. Sender, New York.—"*Preservative.*"[3] Sodium sulphite, 65 per cent; sodium sulphate, 34 per cent; colored with an aniline dye. Directions: One ounce to 50 pounds of chopped meat.

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[1] Duncan Stewart, Vermont Agl. Expt. Station, 1898, 355.

[2] Jenkins, Mitchell & Ogden, Report Conn. Agl. Expt. Station, 1899, Pt. II, p. 141.

[3] Unpublished results of Chemical Division, U. S. Department of Agriculture.

[4] Venzke & Schorer, D. Fleisch-Ztg., 21, Nos. 20, 21, and 24; abs. Chem. C. B., 1893, II, 1020.

[5] E. Polenske, Arb. Kais. Ges. Amt., 1896, 12, 548.

[6] E. Polenske, Arb. Kais. Ges. Amt., 1892, 12, 256.

[7] E. Polenske, Arb. Kais. Ges. Amt., 1892, 8, 686.

[8] E. Polenske, Arb. Kais. Ges. Amt., 1890, 6, 119.

M. Stare, Charlottenburg.—*Konservator.*[1] Salt, 42.3 per cent; borax, 32.3 per cent; sugar, 4 per cent; sulphurous acid, 6 per cent.

M. Stare, Charlottenburg.—*Wurstsalz.*[1] Percentage composition: Boric acid, 60.2; sodium salicylate, 7.6; saltpeter, 12.8; salt, 7.7; sugar, 6.8; water, 5.

M. Starke, Berlin.—*Sanitat.*[1] One liter contains 45 grams boric acid, 8.5 grams salt, and 2.5 grams calcium and sodium sulphates. For use three-fourths liter of this solution is to be mixed with 4 bucketfuls of water, together with 80 grams of "Mehl," which consists of crude boric acid.[3]

Karl Stern, Vienna.—*Dreifaches Konservirungssalz.*[2] Percentage composition: Borax, 80; boric acid, 17; salt, 3.

U. S. Salix Company, New Concord, Ohio.—*Compound extract of salyx.*[3] The sample consisted of salicylic acid.

U. S. Salix Company, New Concord, Ohio.—*Terra Fusa.*[3] Identical with compound extract of salyx.

U. S. Salix Company, New Concord, Ohio.—"*Per Algretta*" for preserving eggs.[3] Identical with compound extract of salyx.

U. S. Salix Company, New Concord, Ohio.—*Hyper-Samphire.*[3] Identical with compound extract of salyx.

Alfred Vacano, Vienna.—*Konservirungssalz.* Sample contained ammonium silicofluorid, 85 per cent; ammonium fluorid, 15 per cent.

A. Wasmuth & Co., Barmen.—*Dr. C. Ruger's Barmenit.*[1] and [4]. Consists of equal parts of boric acid and salt.

L. Ziffer, Berlin.—*Best Australian and New Zealand Meat Preserve.*[5] Percentage composition: Salt, 33.12; sodium sulphate, 48.62; sodium bisulphite, 16; lime, magnesia, and water, 1.70.

L. Ziffer, Berlin.—*Real Australian Meat Preserve.*[6] Percentage composition: Sodium sulphite, 19; sodium sulphate, 79; sodium chlorid, 2.

L. Ziffer, Berlin.—*Best Australian and New Seeland Meat Preserve.*[6] Solution of calcium sulphite containing 7.7 per cent of sulphurous acid.

L. Ziffer, Berlin.—*Best Australian and New Seeland Meat Preserve.*[6] Sodium sulphite, 23; sodium sulphate, 37; sodium chlorid, 40.

L. Ziffer, Berlin.—*Carnat.* Percentage composition: Salt, 43; sodium sulphite (dry), 25; sodium sulphate, 27; sugar, 5.[1] Second analysis: Sodium sulphate, 18.9; salt, 40.12; sodium sulphite, 30.88; sodium carbonate, 1.60; water, 2.10.[5] A teaspoonful is directed with each 5 kilograms (11 pounds) of meat.

L. Ziffer, Berlin.—*Doppelt Konz. Sulphit Natron.*[6] Solution containing 254 grams crystallized sodium bisulphite and 71 grams crystallized sodium sulphate per liter.

L. Ziffer, Berlin.—*Erhaltungspulver.* Percentage composition: Salt, 30; boric acid, 68.5; sodium sulphate, 1.5.[1] Second analysis: Salt, 28.30; boric acid, 70.10; water, 1.34.[5]

L. Ziffer, Berlin.—*Konservesalz.*[1] Percentage composition: Boric acid, 30; saltpeter, 35; salt, 33; sodium sulphate, 2.

L. Ziffer, Berlin.—*Monopol.*[5] Percentage composition: Saltpeter, 43.32; potassium carbonate, 15; potassium chlorid, 17.25; sodium chlorid, 1.20; sugar, 20; water, 3. It is directed to use 300 grams of Monopol with 500 kilograms of meat (10 grams per 100 pounds).

L. Ziffer, Berlin.—*Preservaline.*[1] A solution containing 240 grams salt, 300 grams sodium sulphite (cryst), and 130 grams sodium sulphate per liter.

L. Ziffer, Berlin.—*Preservaline for ham, bacon, etc.*[5] A solution with specific gravity of 1.275 at 15°, and containing 206.7 grams salt, 185 grams sodium sulphite and bisulphite, and 14.2 grams sodium sulphate per liter.

William Zinsser & Co., New York.—*Compressed Preserving Powders.*[7] Sample contained 49.01 per cent salicylic acid and some sugar. Directions: One-half ounce for one-half barrel of beer.

Charles Zoller, New York.—*A. Boake Roberts & Co.'s K. M. S. in tablet form.*[7] Percentage composition: Sulphate of potash, 11.34; bisulphite of soda, 1.84; bisulphite of potash, 84.35. Directions: An eighth to a quarter of an ounce per American barrel.

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[1] E. Polenske, Arb. Kais. Ges. Amt., 1896, 12, 548.
[2] E. Polenske, Arb. Kais. Ges. Amt., 1894, 10, 508.
[3] Unpublished results of Chemical Division, U. S. Department of Agriculture.
[4] E. Polenske, Arb. Kais. Ges. Amt., 1890, 6, 119.
[5] E. Polenske, Arb. Kais. Ges. Amt., 1892, 12, 256.
[6] Venzke & Schorer, D. Fleisch-Ztg., 21, Nos. 20, 21, and 24; abs. Chem. C. B., 1893, II, 1020.
[7] Jenkins, Mitchell & Ogden, Report Conn. Agl. Expt. Station, 1898, 355.

CHARLES ZOLLER, NEW YORK.—*Boake's Genuine K. M. S. Crystals.*[1] The sample consisted of potassium meta-bisulphite, and contained 57 per cent of sulphurous acid.

MANUFACTURER NOT GIVEN.—*Antisourine.*[2] Apparently a solution of borax containing 2.54 per cent of total solids.

MANUFACTURER NOT GIVEN.—*Ohrtmann's Real Australian Meat Preserve.*[3] Sample contained 4.01 per cent calcium bisulphite and 3.64 per cent of free sulphurous acid.

MANUFACTURER NOT GIVEN.—*Koenig's Technical Antiseptic Salt.*[4] Said by authors to be from America, also known as Koenig's pure antiseptic salt. Consists of 85 per cent of commercial ammonium silicofluorid and 15 per cent of ammonium fluroid.

MANUFACTURER NOT GIVEN.—*Konservessenz.*[5] A solution of calcium bisulphite containing 6.24 per cent of sulphurous acid.

MANUFACTURER NOT GIVEN.—*Mannheim Konservesalz.*[5] Salt, 56 per cent; boric acid, 44 per cent.

MANUFACTURER NOT GIVEN.—*Konservirungsflussigkeit fur Wurstgut.*[6] Slightly opalescent, odorless liquid, having an acid reaction and specific gravity of 1.0605 at 20°. Percentage composition: Saltpeter, 3.34; boric acid, 2.75; glycerin, 5.

MANUFACTURER NOT GIVEN.—*Meat Preserve.*[7] Solution of calcium sulphite containing 6.80 per cent sulphurous acid.

MANUFACTURER NOT GIVEN.—*The Real American Meat Preserve.*[6] Saturated solution of calcium sulphite, with specific gravity of 1.0842 at 20°. Contains 2.64 per cent calcium oxid and 8.96 per cent of sulphur dioxid.

MANUFACTURER NOT GIVEN.—*Preservesalz.*[8] Represented as the preservative used in the preparation of American hams. Percentage composition: Borax, 83.8; salt, 3.2; water, 13.

MANUFACTURER NOT GIVEN.—*Sozlith.*[5] Percentage composition: Sodium sulphite, 20; sodium sulphate, 80.

MANUFACTURER NOT GIVEN.—*Wickershaimersche Flussigkeit zur Konservirung von Nahrungsmitteln.*[6] A viscous, almost colorless, slightly opalescent liquid with a specific gravity of 1.0995 at 20°. Percentage composition: Boric acid, 5.23; salt, 1.83; sodium salicylate, 30; glycerin, 25. The glycerin is partly present as boroglycerid.

## THE BEET-SUGAR INDUSTRY IN THE UNITED STATES.

The condition of the beet-sugar industry in this country for the manufacturing season of 1899 and 1900, as well as its development, is shown in the following tables. In 1879 there were only four beet-sugar factories in the United States (California, 2; Delaware, 1; Maine, 1), with a total investment of $365,000 and 350 employees. A new impetus was given to the industry by the investigations and the distribution of seed begun by this Department in 1897.

*Number and nominal daily capacity of establishments in 1900, 1899, and 1898.*

| States and Territories. | 1900. | | 1899. | | | 1898. | |
|---|---|---|---|---|---|---|---|
| | Number of establishments. | Nominal daily capacity, in tons of beets. | Number of establishments. | Nominal daily capacity, in tons of beets. | Capital invested. | Number of establishments. | Nominal daily capacity, in tons of beets. |
| The United States | [9]37 | 22,310 | [10]31 | 19,110 | $20,958,519 | 15 | 7,560 |
| California | 8 | 9,900 | [7]8 | 9,900 | 10,139,780 | 5 | 4,400 |
| Michigan | 10 | 4,450 | 9 | 4,100 | 4,013,743 | 1 | 400 |
| Colorado | 3 | 1,850 | 1 | 350 | | ........ | ........ |
| Illinois | 1 | 700 | 1 | 700 | | ........ | ........ |
| Minnesota | 1 | 400 | 1 | 400 | | 1 | 400 |
| Nebraska | 3 | 1,260 | 3 | 1,260 | | 2 | 660 |
| New Mexico | 1 | 200 | 1 | 200 | | 1 | 200 |
| New York | 3 | 1,000 | 2 | 400 | 6,804,996 | 2 | 400 |
| Ohio | 1 | 400 | ........ | ........ | | ........ | ........ |
| Oregon | 1 | 350 | 1 | 350 | | 1 | 350 |
| Utah | 4 | [11]1,450 | 3 | [12]1,100 | | 2 | 750 |
| Washington | 1 | 350 | 1 | 350 | | ........ | ........ |

[1] Unpublished results of Chemical Division, U. S. Department of Agriculture.
[2] Duncan Stewart, Vermont Agl. Expt. Station, 1898, 355.
[3] E. Polenske, Arb. Kais. Ges. Amt., 1890, 6, 119.
[4] Hefelmann and Mann., Pharm. Centr. Ha, 1895, 16, 249.
[5] E. Polenske, Arb. Kais. Ges. Amt., 1896, 12, 548.
[6] E. Polenske, Arb. Kais. Ges. Amt., 1889, 5, 364.
[7] Venzke & Schorer, D. Fleisch-Ztg., 21, Nos. 20, 21, and 24; abs. Chem. C. B., 1893, II, 1020.
[8] E. Polenske, Arb, Kais. Ges. Amt., 1892, 8, 686.
[9] Includes two idle establishments.
[10] Includes one idle establishment.
[11] Includes two auxiliary factories.
[12] Includes one auxiliary factory at which no sugar is manufactured, but juice is extracted from the beets and pumped to a central factory for treatment.

The benefit of the development of the manufacture of beet sugar is shown in part by the wages paid to labor and the investment of capital. The total of wages in 1900 was $1,092,207 to 1,970 persons in addition to $356,675 for salaries to 350 persons. Of these amounts nearly half belongs to California and a little less than half the remainder to Michigan. The distribution of capital in active use and the total return are shown in the following table:

*Cost of materials used and value of products, 1899–1900.*

| States and Territories. | Total cost of materials. | Sugar beets. | Fuel. | Mill supplies. | Freight paid. | All other materials. | Value of all products. |
|---|---|---|---|---|---|---|---|
| The United States.. | $4,803,796 | $3,485,320 | $453,036 | $18,933 | $369,070 | [1] $477,437 | $7,323,857 |
| California | 2,243,580 | 1,585,953 | 253,185 | 10,011 | 205,286 | 189,145 | 3,499,996 |
| Michigan | 1,109,903 | 902,592 | 90,969 | 2,840 | 26,839 | 86,663 | 1,602,266 |
| All other | 1,450,313 | 996,775 | 108,882 | 6,082 | 136,945 | 201,629 | 2,221,595 |

[1] Includes $51,000, cost of sugar-beet juice.

The extent of the cultivation of sugar beets in the United States is shown by the following figures, including the average tons produced per acre and the average price per ton:

*Acreage, production, and sugar content of beets, 1899–1900.*

| States and Territories. | Total. | | Average tons per acre. | Total cost. | Average price per ton. | Average quality of beets. | |
|---|---|---|---|---|---|---|---|
| | Acres in beets. | Tons of beets (2,000 pounds). | | | | Per cent of sucrose. | Coefficient of purity. |
| The United States... | 135,305 | 794,658 | [1] 5.87 | $3,485,320 | $4.39 | 14.5 | 81.2 |
| California | 63,878 | 354,942 | 5.55 | 1,585,953 | 4.47 | 15.9 | 81.2 |
| Michigan | 37,034 | 205,925 | 5.56 | 902,592 | 4.38 | 13.3 | 82.9 |
| All other | 34,393 | 233,791 | 6.79 | 996,775 | 4.26 | 13.6 | 79.7 |

[1] The season of 1899 was extremely unfavorable, especially in California and Washington. The yield in Germany in 1896–7 and 1897–8 was 14 tons per acre, and in 1898–9 was 13 tons per acre.

The total number of acres grown by factory proprietors was 10,239, with a product of 23,241 tons, worth $93,898; by tenants of factory proprietors, 13,074 acres, with a product of 95,071 tons, worth $430,479; and by contract with persons other than tenants of factory proprietors, 111,992 acres, with a product of 676,344 tons, worth $2,960,943.

Of the four factories reported in 1879, only the one at Alvarado, Cal., has been a permanent success, as the other three have long since been abandoned. Only two factories, both located in California, were in operation in 1889. The total output for that year was reported by the California State board of agriculture to be 2,457 tons (2,000 pounds) of sugar, having approximately a value of $275,000.

Six new factories were built for the crop of 1900–1901. The capital invested in these six factories was approximately $3,800,000. In 1900 there was $24,758,519 invested in the industry. Only 123,400 acres were seeded for the beet crop of 1900, while 200,000 acres would have been necessary to permit the 36 factories then in operation to work to their full capacity. A private, reliable estimate of the beet sugar produced in the United States during the season of 1900–1901 places the total at 76,859 tons of 2,240 pounds.

The key to a permanent and largely profitable success for the beet-sugar industry in this country is believed by many persons familiar with its progress to lie in the use of the pulp as feed for stock. The total value of the pulp fed in 1899–1900 is placed at $21,822, of which $6,968 belongs to California, $241 to Michigan, and $14,613 to other States.

The feeding value of beet pulp has been calculated to be $1.17 per ton of 2,000 pounds. A comparison with other feeding stuffs is afforded by the following table:

*Average composition of sugar-beet pulp and certain other cattle foods in common use.*

| Feeding stuffs. | IN THE FRESH OR AIR-DRY MATERIAL. | | | | | | CALCULATED TO WATER-FREE SUBSTANCE. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Moisture. | Ash. | Protein (nitrogen × 6.25). | Crude fiber. | Nitrogen-free extract. | Fat (ether extract). | Ash. | Protein (nitrogen × 6.25). | Crude fiber. | Nitrogen-free extract. | Fat (ether extract). |
| | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* | *Per ct.* |
| Sugar-beet pulp, pressed | 89.1 | 1.4 | 0.9 | 2.0 | 6.5 | 0.1 | 12.8 | 8.4 | 18.2 | 59.8 | 0.8 |
| Corn fodder (average of several varieties) | 79.3 | 1.2 | 1.8 | 5.0 | 12.2 | 0.5 | 5.6 | 8.8 | 24.1 | 58.9 | 2.6 |
| Sorghum, whole plant | 79.4 | 1.1 | 1.3 | 6.1 | 11.6 | 0.5 | 5.3 | 6.5 | 29.7 | 56.2 | 2.3 |
| Timothy | 61.6 | 2.1 | 3.1 | 11.8 | 20.2 | 1.2 | 5.4 | 8.0 | 30.7 | 52.8 | 3.1 |
| Red clover | 70.8 | 2.1 | 4.4 | 8.1 | 13.5 | 1.1 | 7.2 | 15.3 | 27.8 | 45.8 | 3.9 |
| Alfalfa | 71.8 | 2.7 | 4.8 | 7.4 | 12.3 | 1.0 | 9.4 | 17.1 | 26.2 | 43.9 | 3.4 |
| Mangel-wurzels | 90.9 | 1.1 | 1.4 | 0.9 | 5.5 | 0.2 | 11.5 | 15.2 | 9.5 | 62.0 | 1.8 |
| Turnips | 90.5 | 0.8 | 1.1 | 1.2 | 6.2 | 0.2 | 8.4 | 12.4 | 12.2 | 64.9 | 2.1 |
| Ruta-bagas | 88.6 | 1.2 | 1.2 | 1.3 | 7.5 | 0.2 | 10.1 | 10.4 | 11.2 | 66.8 | 1.3 |
| Sugar-beet pulp, dried | 9.4 | 6.9 | 8.7 | 20.2 | 54.4 | 0.9 | 7.6 | 9.6 | 22.3 | 60.0 | 1.0 |
| Corn meal | 15.0 | 1.4 | 9.2 | 1.9 | 68.7 | 3.8 | 1.6 | 10.8 | 2.2 | 81.0 | 4.4 |
| Gluten meal | 9.6 | 0.7 | 29.4 | 1.6 | 52.4 | 6.3 | 0.8 | 32.5 | 1.8 | 57.9 | 7.0 |
| Wheat bran | 11.9 | 5.8 | 15.4 | 9.0 | 53.9 | 4.0 | 6.6 | 17.4 | 10.2 | 61.3 | 4.5 |

## RURAL FREE-DELIVERY ROUTES, MARCH 1, 1901.

| State. | Routes in operation. | Applications for routes. | State. | Routes in operation. | Applications for routes. |
|---|---|---|---|---|---|
| Alabama | 14 | 25 | Nevada | | |
| Arizona | 2 | | New Hampshire | 46 | 14 |
| Arkansas | 11 | 8 | New Jersey | 35 | 3 |
| California | 71 | 5 | New York | 219 | 219 |
| Colorado | 28 | 20 | North Carolina | 11 | 48 |
| Connecticut | 67 | 23 | North Dakota | 5 | 6 |
| Delaware | 18 | 12 | Ohio | 302 | 567 |
| Florida | 1 | 1 | Oklahoma | | |
| Georgia | 59 | 148 | Oregon | 14 | 25 |
| Idaho | 8 | 9 | Pennsylvania | 201 | 81 |
| Illinois | 337 | 509 | Rhode Island | 10 | 3 |
| Indiana | 314 | 316 | South Carolina | 38 | 72 |
| Iowa | 292 | 516 | South Dakota | 21 | 39 |
| Kansas | 187 | 342 | Tennessee | 106 | 61 |
| Kentucky | 15 | 19 | Texas | 35 | 54 |
| Louisiana | 2 | 4 | Utah | 7 | 2 |
| Maine | 34 | 36 | Vermont | 30 | 15 |
| Maryland | 81 | 61 | Virginia | 16 | 29 |
| Massachusetts | 35 | 30 | Washington | 3 | 19 |
| Michigan | 207 | 415 | West Virginia | 35 | 4 |
| Minnesota | 120 | 105 | Wisconsin | 197 | 214 |
| Mississippi | | 1 | Wyoming | 4 | 3 |
| Missouri | 85 | 225 | | | |
| Montana | | 5 | Total | 3,391 | 4,517 |
| Nebraska | 68 | 204 | | | |

## BOARDS OF TRADE.

| City and State. | Name of organization. | Secretary. |
|---|---|---|
| Baltimore, Md | Chamber of Commerce | W. F. Wheatley. |
| Boston, Mass | Chamber of Commerce | Elwyn G. Preston. |
| Buffalo, N. Y | Merchants' Exchange | C. H. Keep. |
| Chicago, Ill | Board of Trade | George F. Stone. |
| Cincinnati, Ohio | Chamber of Commerce | Chas. B. Murray (superintendent). |
| Denver, Colo | Chamber of Commerce and Board of Trade. | Arthur Williams. |
| Detroit, Mich | Board of Trade | F. W. Waring. |
| Duluth, Minn | Board of Trade | S. A. Kemp. |
| Indianapolis, Ind | Board of Trade | Jacob W. Smith. |
| Louisville, Ky | Board of Trade | J. F. Buckner. |
| Memphis, Tenn | Merchants' Exchange | N. S. Graves. |
| Milwaukee, Wis | Chamber of Commerce | W. J. Langson. |
| New York, N. Y | Produce Exchange | J. C. Brown (statistician). |
| Omaha, Nebr | Board of Trade | L. C. Harding. |

## BOARDS OF TRADE—Continued.

| City and State. | Name of organization. | Secretary. |
|---|---|---|
| Peoria, Ill | Board of Trade | R. C. Grier. |
| Philadelphia, Pa | Commercial Exchange | Armon D. Acheson. |
| Philadelphia, Pa | Produce Exchange | Howard Austin. |
| Portland, Oreg | Board of Trade | P. L. Willis. |
| Richmond, Va | Chamber of Commerce | R. A. Dunlop. |
| St. Louis, Mo | Merchants' Exchange | George H. Morgan. |
| San Francisco, Cal | Chamber of Commerce | E. Scott. |
| San Francisco, Cal | Produce Exchange | T. C. Friedlander. |
| Seattle, Wash | Chamber of Commerce | Thomas W. Prosch. |
| Toledo, Ohio | Produce Exchange | Denison B. Smith. |
| Washington, D. C | Board of Trade | George H. Harries. |

## COTTON EXCHANGES.

| City and State. | Name of organization. | Secretary. |
|---|---|---|
| Atlanta, Ga | Chamber of Commerce | T. H. Martin. |
| Augusta, Ga | Exchange and Board of Trade | W. F. Alexander. |
| Birmingham, Ala | Commercial Club | J. B. Gibson. |
| Charleston, S. C | Cotton Exchange | Rene R. Jervey. |
| Columbia, S. C | Board of Trade | W. E. McNulty. |
| Columbus, Ga | Board of Trade | John C. Coart. |
| Dallas, Tex | Commercial Club | Paul Giraud. |
| Eufaula, Ala | Cotton Exchange | H. Lampley. |
| Fort Worth, Tex | Board of Trade | Talbot O. Bateman. |
| Galveston, Tex | Cotton Exchange and Board of Trade. | S. O. Young. |
| Greenville, Miss | Cotton Exchange | Edward Holland. |
| Greenwood, Miss | Cotton Exchange | C. K. Marshall. |
| Houston, Tex | Cotton Exchange and Board of Trade. | B. R. Warner. |
| Little Rock, Ark | Board of Trade | George R. Brown. |
| Memphis, Tenn | Cotton Exchange | Henry Hotter. |
| Meridian, Miss | Board of Trade and Cotton Exchange. | S. S. Crisler. |
| Mobile, Ala | Cotton Exchange | R. H. Bolling. |
| Monroe, La | Board of Trade | E. D. Windes. |
| Montgomery, Ala | Commercial and Industrial Association. | L. L. Gilbert. |
| Nashville, Tenn | Chamber of Commerce | L. R. Eastman. |
| Natchez, Miss | Cotton and Merchants' Exchange. | W. E. Fitzpatrick. |
| Newbern, N. C | Cotton and Grain Exchange | James Redmond. |
| New Orleans, La | Cotton Exchange | Henry G. Hester. |
| New York, N. Y | Cotton Exchange | Robert P. McDougall. |
| Norfolk and Portsmouth, Va | Cotton Exchange | Norman Bell. |
| Raleigh, N. C | Cotton and Grocers' Exchange | P. T. Wyatt. |
| Richmond, Va | Grain and Cotton Exchange | B. A. Jacobs. |
| Rome, Ga | Board of Trade | A. W. Walton. |
| St. Louis, Mo | Merchants' Exchange | George A. Morgan. |
| Savannah, Ga | Cotton Exchange | J. P. Merrihew. |
| Selma, Ala | Cotton Exchange | C. A. McKinnon. |
| Sherman, Tex | Commercial Club | W. A. Murphy. |
| Shreveport, La | Board of Trade | Henry Hawkins. |
| Texarkana, Ark | Board of Trade | G. A. Hays. |
| Vicksburg, Miss | Cotton Exchange | J. H. Cook. |
| Waco, Tex | Commercial Club | S. L. Jones. |
| Wilmington, N. C | Produce Exchange | John L. Cantwell. |
| Yazoo City, Miss | Cotton Exchange | L. Bowman. |

## STATISTICS OF THE PRINCIPAL CROPS.

### CORN.

The Unitea States produces about four-fifths of the total of corn reported for the whole world, and of the amount that goes into the large markets probably an equal share. The exports[1] of this country last year were the largest ever reported. A comparison for five years will be found on page 849.

The corn crop of the United States in 1900 (2,105,102,516 bushels) was larger than for any other year since the record crop of 1896; it was nearly 10 per cent (180,000,000 bushels) less than the crop of 1896, but was more than one bushel in the hundred

[1] Exports for 1900, because they were grown with the crop of 1899, in crop tables throughout this volume are placed in the year 1899; but in tables of exports the same figures are recorded, of course, in the year 1900, in which the products were exported.

(30,000,000 bushels) heavier than the crop of 1899. The increase was mainly in the great corn States of Iowa, Missouri, and Illinois. In Kansas and Nebraska there was a heavy falling off. There was an increase in acreage of 1,212,285 acres, mainly in the corn region of the central Mississippi Valley. States reporting large increases were: Indiana, 299,000 acres; Illinois, 274,000 acres; Missouri, 188,000; Ohio, 137,000; Nebraska, 800,000. Heavy decreases were reported from Kansas, Mississippi, and Alabama.

The yield per acre for 1900 was 25.3 bushels for the whole country, as against 25.31 in 1899 and 28.19 in 1896. The three States credited with the increase show notably larger returns per acre, while Kansas and Nebraska show smaller. The falling off in Kansas was from 27 bushels in 1899 to 19 bushels in 1900.

The value per acre was $9.02 in 1900, as against $7.66 in 1899 and $6.06 in 1896. There was a marked advance in value for the corn region of the Mississippi Valley, except in Kansas, where the falling off in the production per acre was so large as to offset the advance in price per bushel.

The total value of the crop for 1900 was $751,220,034, the highest figure reached since the crop of 1891, which was worth $836,439,228. It had been exceeded but three times before that year—in 1881, 1882, and 1889, when the values were a few millions in excess of the crop of 1900, but were more than $50,000,000 less than in 1891.

The average farm price on December 1, 1900, was 35.7 cents per bushel for the United States, against 30.28 cents in 1899 and 21.5 cents in 1896. The price in 1891 was nearly 5 cents higher than in 1900. The wholesale prices in Chicago for No. 2 ranged from 30.5 cents in January to 40.5 in December, with a maximum of 49.5 in November. It appears from the figures that there was a fairly steady increase in price in Chicago from March to July, after which the figures were nearly steady till December, when there was a downward movement. Other markets reported follow the Chicago figures approximately, except that in St. Louis the range was not so great and in New York in December prices were maintained. In San Francisco the total advance from January to August was 30 cents, nearly equal to the total initial price in Chicago, the figures going from $1 in January to $1.30 in August and $1.20 in December.

Freight rates by river, St. Louis to New Orleans, were the same for the two years.

*Corn crop of the world, 1895–1899.*[1]

| Countries. | 1895. | 1896. | 1897. | 1898. | 1899. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| United States | 2,151,138,000 | 2,283,875,000 | 1,902,968,000 | 1,924,185,000 | 2,078,144,000 |
| Canada (Ontario) | 25,602,000 | 24,830,000 | 25,441,000 | 24,181,000 | 22,356,000 |
| Mexico | 71,906,000 | 76,264,000 | 121,893,000 | 111,347,000 | 110,000,000 |
| Total North America | 2,248,646,000 | 2,384,969,000 | 2,050,302,000 | 2,059,713,000 | 2,210,500,000 |
| Chile | 9,000,000 | 9,000,000 | 8,000,000 | 9,932,000 | 9,000,000 |
| Argentina | 72,000,000 | 80,000,000 | 40,000,000 | 56,000,000 | 75,000,000 |
| Uruguay | 5,840,000 | 5,000,000 | 4,000,000 | 4,000,000 | 6,000,000 |
| Total South America | 86,840,000 | 94,000,000 | 52,000,000 | 69,932,000 | 90,000,000 |
| France | 26,163,000 | 30,426,000 | 30,401,000 | 23,496,000 | 25,548,000 |
| Spain | 15,714,000 | 18,252,000 | 19,644,000 | 14,098,000 | 24,667,000 |
| Portugal | 15,000,000 | 15,000,000 | 15,500,000 | 15,500,000 | 16,000,000 |
| Italy | 70,483,000 | 79,910,000 | 65,891,000 | 79,640,000 | 88,536,000 |
| Austria | 18,720,000 | 17,492,000 | 14,757,000 | 16,074,000 | 14,599,000 |
| Hungary | 142,743,000 | 128,866,000 | 102,239,000 | 124,682,000 | 113,807,000 |
| Croatia Slavonia | 17,454,000 | 17,617,000 | 14,162,000 | 20,457,000 | 14,106,000 |
| Total Austria-Hungary | 178,917,000 | 163,975,000 | 131,158,000 | 161,213,000 | 142,512,000 |
| Roumania | 71,323,000 | 65,428,000 | 79,753,000 | 101,907,000 | 27,721,000 |
| Bulgaria and E. Roumelia | 28,000,000 | 26,400,000 | 25,000,000 | 37,759,000 | 20,462,000 |
| Servia | 17,000,000 | 16,000,000 | 16,000,000 | 24,558,000 | 15,000,000 |
| Russia | 31,693,000 | 23,773,000 | 51,966,000 | 47,918,000 | 30,912,000 |
| Total Europe | 454,293,000 | 439,164,000 | 435,313,000 | 506,089,000 | 391,358,000 |
| Algeria | 493,000 | 451,000 | 301,000 | 347,000 | 349,000 |
| Egypt | 33,600,000 | 34,000,000 | 35,000,000 | 32,000,000 | 30,000,000 |
| Cape Colony | 2,378,000 | 1,650,000 | 2,761,000 | 2,061,000 | 2,858,000 |
| Total Africa | 36,471,000 | 36,101,000 | 38,062,000 | 34,408,000 | 33,207,000 |
| Australasia | 8,500,000 | 10,201,000 | 9,412,000 | 9,780,000 | 10,025,000 |

[1] The figures in this and succeeding tables were furnished by the Division of Statistics, Department of Agriculture, except such as otherwise credited. All prices are on gold basis.

*Corn crop of the world, 1895–1899*—Continued.

RECAPITULATION BY CONTINENTS.

| Continents. | 1895. | 1896. | 1897. | 1898. | 1899. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| North America | 2,248,646,000 | 2,384,969,000 | 2,050,302,000 | 2,059,713,000 | 2,210,500,000 |
| South America | 86,840,000 | 94,000,000 | 52,000,000 | 69,932,000 | 90,000,000 |
| Europe | 454,293,000 | 439,164,000 | 435,313,000 | 506,089,000 | 391,358,000 |
| Africa | 36,471,000 | 36,101,000 | 38,062,000 | 34,408,000 | 33,207,000 |
| Australasia | 8,500,000 | 10,201,000 | 9,412,000 | 9,780,000 | 10,025,000 |
| | 2,834,750,000 | 2,964,435,000 | 2,585,089,000 | 2,679,922,000 | 2,735,090,000 |

*Visible supply of corn in the United States the first of each month for ten years.*

| Month. | 1891-1892. | 1892-1893. | 1893-1894. | 1894-1895. | 1895-1896. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| July | 4,860,218 | 9,479,594 | 10,151,000 | 7,793,000 | 10,762,000 |
| August | 4,722,000 | 8,897,000 | 9,995,000 | 4,816,000 | 5,770,000 |
| September | 6,668,307 | 8,780,329 | 6,996,000 | 4,295,000 | 6,819,000 |
| October | 8,585,647 | 12,265,189 | 9,986,000 | 5,206,000 | 6,760,000 |
| November | 4,151,000 | 15,188,394 | 11,318,000 | 3,353,000 | 6,338,000 |
| December | 3,329,273 | 12,616,101 | 9,412,000 | 6,380,000 | 7,381,000 |
| January | 8,588,075 | 13,523,251 | 11,335,000 | 12,882,000 | 9,164,000 |
| February | 8,991,691 | 14,455,000 | 19,183,000 | 16,733,000 | 17,035,000 |
| March | 12,546,610 | 18,037,000 | 22,758,000 | 17,001,000 | 17,040,000 |
| April | 13,287,608 | 17,236,000 | 21,362,000 | 16,330,000 | 19,290,000 |
| May | 8,101,189 | 13,025,000 | 14,881,000 | 11,602,000 | 13,239,000 |
| June | 4,843,503 | 9,497,000 | 9,555,000 | 12,629,000 | 11,231,000 |

| Month. | 1896-1897. | 1897-1898. | 1898-1899. | 1899-1900. | 1900-1901. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| July | 11,199,000 | 21,501,000 | 32,983,000 | 21,551,000 | 19,087,000 |
| August | 13,246,000 | 20,018,000 | 25,430,000 | 17,687,000 | 18,613,000 |
| September | 18,608,000 | 37,528,000 | 24,043,000 | 11,070,000 | 8,766,000 |
| October | 17,800,000 | 45,412,000 | 30,132,000 | 16,662,000 | 11,106,000 |
| November | 23,913,000 | 52,980,000 | 33,198,000 | 18,738,000 | 11,061,000 |
| December | 22,635,000 | 49,559,000 | 25,870,000 | 17,555,000 | 12,791,000 |
| January | 26,457,000 | 48,292,000 | 26,936,000 | 19,024,000 | 14,313,000 |
| February | 29,725,000 | 53,522,000 | 36,726,000 | 20,110,000 | 21,950,000 |
| March | 33,764,000 | 52,457,000 | 44,792,000 | 28,340,000 | 27,538,000 |
| April | 32,670,000 | 52,228,000 | 43,618,000 | 31,883,000 | 28,947,000 |
| May | 21,707,000 | 34,734,000 | 34,236,000 | 30,416,000 | ........ |
| June | 16,161,000 | 28,288,000 | 19,070,000 | 18,289,000 | ........ |

*Condition of the corn crop of the United States, monthly, 1886–1900.*

| Year. | July. | Aug. | Sept. | Oct. | Year. | July. | Aug. | Sept. | Oct. | Year. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1886 | 95.2 | 80.7 | 76.6 | 80.0 | 1891 | 92.8 | 90.8 | 91.1 | 92.5 | 1896 | 92.4 | 96.0 | 91.0 | 90.5 |
| 1887 | 97.7 | 80.5 | 72.3 | 72.8 | 1892 | 81.1 | 82.5 | 79.6 | 79.8 | 1897 | 82.9 | 84.2 | 79.3 | 77.1 |
| 1888 | 93.0 | 95.5 | 94.2 | 92.0 | 1893 | 93.2 | 87.0 | 76.7 | 75.1 | 1898 | 90.5 | 87.0 | 84.1 | 82.0 |
| 1889 | 90.3 | 94.8 | 90.9 | 91.7 | 1894 | 95.0 | 69.1 | 63.4 | 64.2 | 1899 | 86.5 | 89.9 | 85.2 | 82.7 |
| 1890 | 93.1 | 73.3 | 70.1 | 70.6 | 1895 | 99.3 | 102.5 | 96.4 | 95.5 | 1900 | 89.5 | 87.5 | 80.6 | 78.2 |

## WHITE CORN COMPARED WITH COLORED CORN.

From the results of hundreds of tests at experiment stations in all parts of the country it appears that heavier yields can be secured from white than from colored varieties. In 1,267 comparative tests with 490 varieties the average yield of 217 white varieties has been 2.5 bushels per acre in excess of the average yield of the 273 colored varieties grown in the same tests. At only one of the stations from which such tests have been reported have colored varieties given the heavier yield.

*Acreage, production, value, prices, and exports of corn of the United States, 1866 to 1900, inclusive.*

| Year. | Acreage. | Average yield per acre. | Production. | Average farm price per bushel, Dec. 1. | Farm value, Dec. 1. | Chicago cash price per bushel, No. 2. December. Low. | December. High. | May of following year. Low. | May of following year. High. | Domestic exports,[1] including corn meal, fiscal years beginning July 1. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Acres.* | *Bush.* | *Bushels.* | *Cents.* | *Dollars.* | *Cts.* | *Cts.* | *Cts.* | *Cts.* | *Bushels.* |
| 1866 | 34,306,538 | 25.3 | 867,946,295 | 47.4 | 411,450,830 | 53 | 62 | 64 | 79 | 16,026,947 |
| 1867 | 32,520,249 | 23.6 | 768,320,000 | 57.0 | 437,769,763 | 61 | 65 | 61 | 71 | 12,493,522 |
| 1868 | 34,887,246 | 26.0 | 906,527,000 | 46.8 | 424,056,649 | 38 | 58 | 44 | 51 | 8,286,665 |
| 1869 | 37,103,245 | 23.6 | 874,320,000 | 59.8 | 522,550,509 | 56 | 67 | 73 | 85 | 2,140,487 |
| 1870 | 38,646,977 | 28.3 | 1,094,255,000 | 49.4 | 540,520,456 | 41 | 59 | 46 | 52 | 10,676,873 |
| 1871 | 34,091,137 | 29.1 | 991,898,000 | 43.4 | 430,355,910 | 36 | 39 | 38 | 43 | 35,727,010 |
| 1872 | 35,526,836 | 30.8 | 1,092,719,000 | 35.3 | 385,736,210 | 27 | 28 | 31 | 39 | 40,154,374 |
| 1873 | 39,197,148 | 23.8 | 932,274,000 | 44.2 | 411,961,151 | 40 | 49 | 49 | 59 | 35,985,834 |
| 1874 | 41,036,918 | 20.7 | 850,148,500 | 58.4 | 496,271,255 | 64 | 76 | 53 | 67 | 30,025,036 |
| 1875 | 44,841,371 | 29.5 | 1,321,069,000 | 36.7 | 484,674,804 | 40 | 47 | 41 | 45 | 50,910,532 |
| 1876 | 49,033,364 | 26.2 | 1,283,827,500 | 34.0 | 436,108,521 | 40 | 43 | 43 | 56 | 72,652,611 |
| 1877 | 50,369,113 | 26.7 | 1,342,558,000 | 34.8 | 467,635,230 | 41 | 49 | 35 | 41 | 87,192,110 |
| 1878 | 51,585,000 | 26.9 | 1,388,218,750 | 31.7 | 440,280,517 | 30 | 32 | 33 | 36 | 87,884,892 |
| 1879 | 53,085,450 | 29.2 | 1,547,901,790 | 37.5 | 580,486,217 | 39 | 43¼ | 32⅜ | 36⅛ | 99,572,329 |
| 1880 | 62,317,842 | 27.6 | 1,717,434,543 | 39.6 | 679,714,499 | 35⅝ | 42 | 41½ | 45 | 93,648,147 |
| 1881 | 64,262,025 | 18.6 | 1,194,916,000 | 63.6 | 759,482,170 | 58½ | 63½ | 69 | 76⅞ | 44,340,683 |
| 1882 | 65,659,545 | 24.6 | 1,617,025,100 | 48.5 | 783,867,175 | 49¼ | 61 | 53¼ | 56¾ | 41,655,653 |
| 1883 | 68,301,889 | 22.7 | 1,551,066,895 | 42.4 | 658,051,485 | 54¼ | 63⅛ | 52½ | 57 | 46,258,606 |
| 1884 | 69,683,780 | 25.8 | 1,795,528,000 | 35.7 | 640,735,560 | 34½ | 40¼ | 44¾ | 49 | 52,876,456 |
| 1885 | 73,130,150 | 26.5 | 1,936,176,000 | 32.8 | 635,674,630 | 36 | 42¾ | 34¼ | 36¾ | 64,829,617 |
| 1886 | 75,694,208 | 22.0 | 1,665,441,000 | 36.6 | 610,311,000 | 35¾ | 38 | 36⅞ | 39⅜ | 41,368,584 |
| 1887 | 72,392,720 | 20.1 | 1,456,161,000 | 44.4 | 646,106,770 | 47 | 51⅛ | 54 | 60 | 25,360,869 |
| 1888 | 75,672,763 | 26.3 | 1,987,790,000 | 34.1 | 677,561,580 | 33½ | 35⅞ | 33⅛ | 35⅜ | 70,841,673 |
| 1889 | 78,319,651 | 27.0 | 2,112,892,000 | 28.3 | 597,918,829 | 29¼ | 35 | 32¾ | 35 | 103,418,709 |
| 1890 | 71,970,763 | 20.7 | 1,489,970,000 | 50.6 | 754,433,451 | 47¾ | 53 | 55 | 69½ | 32,041,529 |
| 1891 | 76,204,515 | 27.0 | 2,060,154,000 | 40.6 | 836,439,228 | 39⅜ | 59 | 40¾ | [2] 100 | 76,602,285 |
| 1892 | 70,626,658 | 23.1 | 1,628,464,000 | 39.4 | 642,146,630 | 40 | 42⅞ | 39½ | 44½ | 47,121,894 |
| 1893 | 72,036,465 | 22.5 | 1,619,496,131 | 36.5 | 591,625,627 | 34¼ | 36½ | 36¾ | 38½ | 66,489,529 |
| 1894 | 62,582,269 | 19.4 | 1,212,770,052 | 45.7 | 554,719,162 | 44¾ | 47½ | 47¾ | 55½ | 28,585,405 |
| 1895 | 82,075,830 | 26.2 | 2,151,138,580 | 25.3 | 544,985,534 | 25 | 26¾ | 27½ | 29½ | 101,100,375 |
| 1896 | 81,027,156 | 28.2 | 2,283,875,165 | 21.5 | 491,006,967 | 22½ | 23¾ | 23 | 25½ | 178,817,417 |
| 1897 | 80,095,051 | 23.8 | 1,902,967,933 | 26.3 | 501,072,952 | 25 | 27½ | 32⅜ | 37 | 212,055,543 |
| 1898 | 77,721,781 | 24.8 | 1,924,184,660 | 28.7 | 552,023,428 | 33⅛ | 38 | 32½ | 34⅜ | 177,255,046 |
| 1899 | 82,108,587 | 25.3 | 2,078,143,933 | 30.3 | 629,210,110 | 30 | 31½ | 36 | 40½ | 213,123,401 |
| 1900 | 83,320,872 | 25.3 | 2,105,102,516 | 35.7 | 751,220,034 | 35¼ | 40½ | ...... | ...... | ........... |

[1] See footnote, page 753.　　[2] Coincident with "corner."

*Acreage, production, value, and distribution of corn of the United States in 1900, by States.*

| States and Territories. | Crop of 1900. Acreage. | Production. | Value. | Stock on hand Mar. 1, 1901. | | Shipped out of county where grown. |
|---|---|---|---|---|---|---|
| | *Acres.* | *Bushels.* | *Dollars.* | *Bushels.* | *Per cent.* | *Bushels.* |
| Maine | 12,229 | 440,244 | 242,134 | 127,671 | 29 | 0 |
| New Hampshire | 25,264 | 934,768 | 523,470 | 327,169 | 35 | 0 |
| Vermont | 48,477 | 1,939,080 | 969,540 | 678,678 | 35 | 0 |
| Massachusetts | 40,667 | 1,545,346 | 834,487 | 432,697 | 28 | 0 |
| Rhode Island | 8,197 | 262,304 | 175,744 | 102,299 | 39 | 5,246 |
| Connecticut | 46,610 | 1,771,180 | 974,149 | 673,048 | 38 | 0 |
| New York | 538,626 | 17,236,032 | 8,100,935 | 5,687,891 | 33 | 344,721 |
| New Jersey | 257,364 | 8,493,012 | 3,821,855 | 3,482,135 | 41 | 1,019,161 |
| Pennsylvania | 1,308,316 | 32,707,900 | 14,718,555 | 10,466,528 | 32 | 2,943,711 |
| Delaware | 208,763 | 5,010,312 | 1,903,919 | 2,304,744 | 46 | 1,803,712 |
| Maryland | 585,877 | 15,232,802 | 6,245,449 | 5,483,809 | 36 | 3,808,200 |
| Virginia | 1,761,485 | 28,183,760 | 13,810,042 | 9,582,478 | 34 | 2,254,701 |
| North Carolina | 2,482,515 | 29,790,180 | 16,980,403 | 11,916,072 | 40 | 1,489,509 |
| South Carolina | 1,875,591 | 13,129,137 | 8,402,648 | 4,070,032 | 31 | 262,583 |
| Georgia | 3,411,953 | 34,119,530 | 19,448,132 | 17,400,960 | 51 | 2,047,172 |
| Florida | 519,524 | 4,156,192 | 2,493,715 | 1,828,724 | 44 | 207,810 |
| Alabama | 2,668,722 | 29,355,942 | 17,026,446 | 11,155,258 | 38 | 587,119 |
| Mississippi | 2,293,818 | 25,231,998 | 14,634,559 | 7,569,599 | 30 | 504,640 |
| Louisiana | 1,453,094 | 24,702,598 | 12,351,299 | 8,645,909 | 35 | 988,104 |
| Texas | 4,553,495 | 81,962,910 | 38,522,568 | 27,047,760 | 33 | 6,557,033 |
| Arkansas | 2,380,313 | 45,225,947 | 19,447,157 | 17,638,119 | 39 | 3,165,816 |
| Tennessee | 2,849,894 | 56,997,880 | 27,928,961 | 20,519,237 | 36 | 5,699,788 |
| West Virginia | 714,804 | 19,299,708 | 9,649,854 | 6,754,898 | 35 | 1,736,974 |
| Kentucky | 2,664,124 | 69,267,224 | 27,706,890 | 25,628,873 | 37 | 6,926,722 |
| Ohio | 2,888,924 | 106,890,188 | 36,342,664 | 40,618,271 | 38 | 22,446,939 |

*Acreage, production, value, and distribution of corn of the United States in 1900, by States*—Continued.

| States and Territories. | Crop of 1900. Acreage. | Crop of 1900. Production. | Crop of 1900. Value. | Stock on hand Mar. 1, 1901. | Stock on hand Mar. 1, 1901. | Shipped out of county where grown. |
|---|---|---|---|---|---|---|
| | *Acres.* | *Bushels.* | *Dollars.* | *Bushels.* | *Per cent.* | *Bushels.* |
| Michigan | 1,080,235 | 38,888,460 | 14,388,730 | 14,777,615 | 38 | 3,888,846 |
| Indiana | 4,031,600 | 153,200,800 | 49,024,256 | 59,748,312 | 39 | 47,492,248 |
| Illinois | 7,139,898 | 264,176,226 | 84,536,392 | 105,670,490 | 40 | 113,595,777 |
| Wisconsin | 1,238,681 | 49,547,240 | 16,350,589 | 18,332,479 | 37 | 5,945,669 |
| Minnesota | 963,476 | 31,794,708 | 9,220,465 | 11,128,148 | 35 | 3,815,365 |
| Iowa | 8,048,946 | 305,859,948 | 82,582,186 | 119,285,380 | 39 | 94,816,584 |
| Missouri | 6,453,943 | 180,710,404 | 57,827,329 | 68,669,954 | 38 | 28,913,665 |
| Kansas | 8,624,770 | 163,870,630 | 52,438,602 | 47,522,483 | 29 | 32,774,126 |
| Nebraska | 8,093,464 | 210,430,064 | 65,233,320 | 73,650,522 | 35 | 69,441,921 |
| South Dakota | 1,200,697 | 32,418,819 | 9,401,458 | 11,670,775 | 36 | 10,049,834 |
| North Dakota | 23,824 | 381,184 | 160,097 | 49,554 | 13 | 3,812 |
| Montana | 1,598 | 23,970 | 14,142 | 2,397 | 10 | 0 |
| Wyoming | 2,403 | 81,702 | 49,021 | 20,426 | 25 | 0 |
| Colorado | 167,839 | 3,188,941 | 1,530,692 | 892,903 | 28 | 159,447 |
| New Mexico | 25,216 | 554,752 | 355,041 | 127,593 | 23 | 66,570 |
| Utah | 8,459 | 169,180 | 106,583 | 25,377 | 15 | 6,767 |
| Washington | 5,307 | 106,140 | 62,623 | 15,921 | 15 | 0 |
| Oregon | 13,789 | 317,147 | 180,774 | 41,229 | 13 | 6,343 |
| California | 54,079 | 1,351,975 | 824,705 | 148,717 | 11 | 94,638 |
| Oklahoma | 544,002 | 14,144,052 | 3,677,454 | 4,243,216 | 30 | 2,545,929 |
| United States | 83,320,872 | 2,105,102,516 | 751,220,034 | 776,166,350 | 36.9 | 478,417,202 |

*Average yield per acre of corn in the United States, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* |
| Maine | 37.5 | 35.5 | 30.3 | 39.9 | 42.0 | 37.0 | 37.0 | 40.0 | 36.0 | 36.0 |
| New Hampshire | 35.8 | 37.8 | 31.7 | 34.3 | 40.2 | 42.0 | 34.0 | 41.0 | 39.0 | 37.0 |
| Vermont | 37.2 | 38.0 | 32.4 | 40.8 | 45.6 | 41.0 | 35.0 | 43.0 | 36.0 | 40.0 |
| Massachusetts | 39.5 | 38.7 | 33.5 | 34.5 | 43.9 | 43.0 | 32.5 | 40.0 | 36.0 | 38.0 |
| Rhode Island | 34.5 | 33.4 | 24.4 | 31.4 | 30.9 | 34.0 | 31.0 | 34.0 | 31.0 | 32.0 |
| Connecticut | 36.0 | 34.5 | 28.2 | 31.0 | 37.9 | 38.0 | 31.5 | 37.0 | 39.0 | 38.0 |
| New York | 31.8 | 33.0 | 29.5 | 28.2 | 35.6 | 34.0 | 31.0 | 33.0 | 31.0 | 32.0 |
| New Jersey | 34.2 | 31.6 | 25.9 | 33.1 | 33.0 | 33.0 | 31.5 | 37.0 | 39.0 | 33.0 |
| Pennsylvania | 33.3 | 30.5 | 24.5 | 32.0 | 33.5 | 40.0 | 36.0 | 37.0 | 32.0 | 25.0 |
| Delaware | 22.0 | 18.7 | 24.6 | 22.0 | 21.0 | 22.0 | 29.0 | 25.0 | 22.0 | 24.0 |
| Maryland | 25.5 | 20.6 | 24.2 | 22.9 | 26.8 | 32.0 | 33.0 | 31.0 | 32.0 | 26.0 |
| Virginia | 19.7 | 15.3 | 18.9 | 19.1 | 18.6 | 21.5 | 18.0 | 22.0 | 20.0 | 16.0 |
| North Carolina | 14.1 | 10.2 | 12.3 | 13.4 | 14.5 | 12.0 | 13.0 | 14.0 | 13.0 | 12.0 |
| South Carolina | 11.6 | 10.5 | 7.7 | 11.2 | 11.1 | 9.0 | 9.0 | 10.0 | 9.0 | 7.0 |
| Georgia | 12.2 | 11.2 | 11.1 | 11.7 | 13.0 | 11.0 | 11.0 | 9.0 | 10.0 | 10.0 |
| Florida | 11.0 | 9.0 | 9.7 | 10.1 | 11.2 | 10.0 | 8.0 | 9.0 | 10.0 | 8.0 |
| Alabama | 12.7 | 12.2 | 11.5 | 13.7 | 15.9 | 12.5 | 12.0 | 15.0 | 12.0 | 11.0 |
| Mississippi | 15.2 | 13.7 | 13.1 | 17.2 | 15.8 | 13.5 | 14.5 | 18.0 | 16.0 | 11.0 |
| Louisiana | 17.3 | 14.8 | 14.2 | 16.2 | 18.8 | 13.0 | 17.0 | 18.0 | 18.0 | 17.0 |
| Texas | 19.5 | 21.4 | 17.6 | 19.0 | 26.4 | 9.5 | 18.5 | 25.0 | 18.0 | 18.0 |
| Arkansas | 21.2 | 17.5 | 16.2 | 19.2 | 21.5 | 13.5 | 16.0 | 20.0 | 20.0 | 19.0 |
| Tennessee | 22.7 | 20.3 | 21.3 | 21.9 | 25.0 | 23.0 | 21.0 | 26.0 | 20.0 | 20.0 |
| West Virginia | 27.3 | 22.5 | 21.7 | 18.5 | 24.2 | 30.0 | 24.5 | 29.0 | 26.0 | 27.0 |
| Kentucky | 30.0 | 23.3 | 23.5 | 23.0 | 31.2 | 28.0 | 23.0 | 31.0 | 21.0 | 26.0 |
| Ohio | 32.0 | 29.4 | 23.8 | 26.3 | 32.6 | 41.0 | 32.5 | 37.0 | 36.0 | 37.0 |
| Michigan | 29.5 | 25.0 | 23.7 | 23.2 | 33.8 | 38.0 | 31.5 | 34.0 | 25.0 | 36.0 |
| Indiana | 33.3 | 29.3 | 24.7 | 28.9 | 32.8 | 35.0 | 30.0 | 36.0 | 38.0 | 38.0 |
| Illinois | 33.5 | 26.2 | 25.7 | 28.8 | 37.4 | 40.5 | 32.5 | 30.0 | 36.0 | 37.0 |
| Wisconsin | 26.7 | 27.3 | 29.8 | 20.7 | 31.8 | 37.0 | 33.0 | 35.0 | 35.0 | 40.0 |
| Minnesota | 26.5 | 27.0 | 28.3 | 18.4 | 31.2 | 30.5 | 26.0 | 32.0 | 33.0 | 33.0 |
| Iowa | 36.7 | 28.3 | 33.9 | 15.0 | 35.1 | 39.0 | 29.0 | 35.0 | 31.0 | 38.0 |
| Missouri | 29.9 | 27.7 | 27.9 | 22.0 | 36.0 | 27.0 | 26.0 | 26.0 | 26.0 | 28.0 |
| Kansas | 26.7 | 24.5 | 21.3 | 11.2 | 24.3 | 28.0 | 18.0 | 16.0 | 27.0 | 19.0 |
| Nebraska | 35.2 | 28.2 | 25.2 | 6.0 | 16.1 | 37.5 | 30.0 | 21.0 | 28.0 | 26.0 |
| South Dakota | 22.5 | 22.3 | 23.7 | 4.2 | 11.1 | 26.0 | 24.0 | 28.0 | 26.0 | 27.0 |
| North Dakota | 18.0 | 21.4 | 20.7 | 19.2 | 21.3 | 35.0 | 17.0 | 19.0 | 23.0 | 16.0 |
| Montana | ...... | 19.4 | 27.5 | 32.7 | 25.0 | 26.0 | 18.0 | 28.0 | 23.0 | 15.0 |
| Wyoming | ...... | 18.5 | 18.5 | 30.0 | 27.5 | 25.0 | 12.0 | 16.0 | 22.0 | 34.0 |
| Colorado | 21.5 | 22.3 | 16.5 | 19.7 | 20.7 | 16.0 | 19.0 | 18.0 | 17.0 | 19.0 |
| New Mexico | 18.3 | 20.0 | 25.3 | 19.1 | 27.2 | 16.0 | 27.0 | 21.0 | 20.0 | 22.0 |
| Utah | 19.0 | 18.0 | 21.5 | 24.4 | 20.3 | 25.0 | 22.0 | 21.0 | 20.0 | 20.0 |
| Washington | ...... | 18.0 | 21.3 | 20.8 | 17.1 | 14.0 | 18.0 | 12.0 | 23.0 | 20.0 |
| Oregon | 27.0 | 21.5 | 24.7 | 25.4 | 26.4 | 22.0 | 25.0 | 24.0 | 22.0 | 23.0 |
| California | 34.5 | 30.3 | 31.7 | 19.3 | 34.5 | 37.0 | 31.5 | 26.0 | 27.0 | 25.0 |
| Oklahoma | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 19.0 | 26.0 |
| General average | 27.03 | 23.06 | 22.48 | 19.38 | 26.21 | 28.19 | 23.76 | 24.76 | 25.31 | 25.3 |

*Average value per acre of corn in the United States, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| Maine | $30.00 | $23.79 | $18.79 | $28.73 | $22.68 | $17.39 | $17.39 | $19.20 | $18.00 | $19.80 |
| New Hampshire | 27.57 | 24.57 | 18.07 | 26.07 | 20.50 | 18.90 | 15.30 | 18.86 | 19.11 | 20.72 |
| Vermont | 28.27 | 24.32 | 19.76 | 28.15 | 21.89 | 15.58 | 15.05 | 18.92 | 16.92 | 20.00 |
| Massachusetts | 30.81 | 23.99 | 20.77 | 21.05 | 22.83 | 19.78 | 15.28 | 19.60 | 18.36 | 20.52 |
| Rhode Island | 27.26 | 21.04 | 16.84 | 23.55 | 17.30 | 16.66 | 16.74 | 21.76 | 16.43 | 21.44 |
| Connecticut | 27.36 | 21.39 | 18.05 | 21.08 | 19.33 | 15.96 | 15.43 | 19.24 | 19.50 | 20.90 |
| New York | 20.99 | 19.80 | 16.23 | 17.20 | 16.02 | 12.92 | 12.40 | 14.19 | 13.95 | 15.04 |
| New Jersey | 22.23 | 18.33 | 13.47 | 17.87 | 13.86 | 11.88 | 11.97 | 14.80 | 15.60 | 14.85 |
| Pennsylvania | 18.98 | 17.38 | 12.00 | 17.60 | 13.07 | 13.20 | 22.24 | 14.80 | 13.12 | 11.25 |
| Delaware | 12.10 | 8.23 | 9.84 | 9.90 | 7.14 | 5.50 | 8.70 | 7.75 | 7.48 | 9.12 |
| Maryland | 13.52 | 9.27 | 10.64 | 11.45 | 9.92 | 10.24 | 9.90 | 10.85 | 11.52 | 10.66 |
| Virginia | 9.85 | 8.11 | 8.69 | 8.98 | 6.88 | 6.88 | 6.84 | 7.70 | 7.60 | 7.84 |
| North Carolina | 8.18 | 5.51 | 6.15 | 6.30 | 5.51 | 4.44 | 5.59 | 6.02 | 6.11 | 6.84 |
| South Carolina | 8.12 | 5.99 | 4.62 | 7.28 | 5.11 | 4.14 | 4.41 | 4.60 | 4.50 | 4.48 |
| Georgia | 8.42 | 6.27 | 6.22 | 6.79 | 5.33 | 4.73 | 5.28 | 4.32 | 5.00 | 5.70 |
| Florida | 8.80 | 5.40 | 6.60 | 7.17 | 5.26 | 5.30 | 4.40 | 4.50 | 5.30 | 4.80 |
| Alabama | 8.00 | 6.34 | 6.79 | 7.26 | 5.88 | 5.63 | 5.52 | 6.15 | 5.64 | 6.38 |
| Mississippi | 8.82 | 6.99 | 7.20 | 8.43 | 5.85 | 5.94 | 6.53 | 7.02 | 7.36 | 6.38 |
| Louisiana | 10.38 | 7.40 | 8.09 | 10.04 | 7.24 | 5.85 | 7.65 | 7.38 | 7.92 | 8.50 |
| Texas | 10.73 | 9.63 | 9.50 | 10.64 | 8.18 | 3.90 | 7.58 | 8.50 | 6.48 | 8.46 |
| Arkansas | 9.75 | 8.23 | 7.29 | 9.02 | 6.88 | 4.99 | 6.40 | 5.80 | 7.60 | 8.17 |
| Tennessee | 9.76 | 8.73 | 8.31 | 8.54 | 6.75 | 6.44 | 7.56 | 7.54 | 7.80 | 9.80 |
| West Virginia | 14.20 | 12.60 | 11.94 | 10.55 | 9.68 | 10.20 | 9.80 | 10.73 | 11.70 | 13.50 |
| Kentucky | 12.00 | 9.32 | 10.11 | 10.12 | 8.42 | 7.00 | 8.05 | 8.37 | 7.77 | 10.40 |
| Ohio | 13.12 | 12.35 | 9.52 | 11.31 | 8.80 | 8.61 | 8.12 | 9.99 | 10.80 | 12.58 |
| Michigan | 14.16 | 11.50 | 10.66 | 11.60 | 10.82 | 9.12 | 8.50 | 11.56 | 9.00 | 13.32 |
| Indiana | 12.65 | 11.72 | 8.89 | 10.69 | 7.54 | 6.65 | 6.30 | 9.00 | 10.26 | 12.16 |
| Illinois | 12.40 | 9.69 | 7.97 | 11.23 | 8.23 | 7.29 | 6.83 | 7.50 | 9.36 | 11.84 |
| Wisconsin | 11.75 | 10.37 | 10.43 | 9.32 | 9.54 | 8.14 | 8.25 | 9.80 | 10.50 | 13.20 |
| Minnesota | 10.33 | 9.99 | 9.62 | 7.91 | 6.24 | 5.79 | 6.24 | 7.68 | 7.92 | 9.57 |
| Iowa | 11.01 | 9.06 | 9.15 | 6.75 | 6.32 | 5.46 | 4.93 | 8.05 | 7.13 | 10.26 |
| Missouri | 11.36 | 9.97 | 8.37 | 8.80 | 7.20 | 5.40 | 6.24 | 7.02 | 7.80 | 8.96 |
| Kansas | 9.08 | 7.60 | 6.60 | 4.82 | 4.62 | 5.04 | 3.96 | 4.16 | 6.75 | 6.08 |
| Nebraska | 9.15 | 7.90 | 6.80 | 3.00 | 2.90 | 4.88 | 5.10 | 4.62 | 6.44 | 8.06 |
| South Dakota | 7.88 | 7.36 | 5.93 | 1.93 | 2.55 | 4.68 | 5.04 | 6.44 | 6.76 | 7.83 |
| North Dakota | 7.20 | 8.56 | 7.87 | 8.45 | 5.11 | 8.75 | 5.44 | 6.84 | 7.59 | 6.72 |
| Montana | ...... | 13.30 | 19.25 | 26.81 | 18.75 | 15.60 | 11.70 | 18.48 | 11.96 | 8.85 |
| Wyoming | ...... | 11.28 | 11.66 | 19.50 | 15.67 | 19.50 | 6.00 | 8.80 | 9.46 | 20.40 |
| Colorado | 11.40 | 8.92 | 8.42 | 12.02 | 8.49 | 5.76 | 7.22 | 7.20 | 7.31 | 9.12 |
| New Mexico | 13.18 | 14.40 | 17.96 | 14.33 | 15.23 | 8.80 | 15.66 | 11.76 | 11.60 | 14.08 |
| Utah | 11.40 | 10.44 | 12.47 | 14.15 | 9.95 | 12.75 | 12.10 | 12.60 | 11.80 | 12.60 |
| Washington | ...... | 10.80 | 13.21 | 14.35 | 6.84 | 7.98 | 9.90 | 5.04 | 12.65 | 11.80 |
| Oregon | 19.17 | 12.04 | 11.61 | 14.22 | 14.52 | 12.32 | 13.25 | 14.40 | 14.08 | 13.11 |
| California | 24.50 | 16.67 | 15.85 | 11.00 | 18.29 | 19.61 | 17.64 | 16.12 | 16.20 | 15.25 |
| Oklahoma | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 3.80 | 6.76 |
| General average | 10.98 | 9.09 | 8.21 | 8.86 | 6.64 | 6.06 | 6.26 | 7.10 | 7.66 | 9.02 |

*Average farm price of corn per bushel in the United States December 1, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| Maine | 80 | 67 | 62 | 72 | 54 | 47 | 47 | 48 | 50 | 55 |
| New Hampshire | 77 | 65 | 57 | 76 | 51 | 45 | 45 | 46 | 49 | 56 |
| Vermont | 76 | 64 | 61 | 69 | 48 | 38 | 43 | 44 | 47 | 50 |
| Massachusetts | 78 | 62 | 62 | 61 | 52 | 46 | 47 | 49 | 51 | 54 |
| Rhode Island | 79 | 63 | 69 | 75 | 56 | 49 | 54 | 64 | 53 | 67 |
| Connecticut | 76 | 62 | 64 | 68 | 51 | 42 | 49 | 52 | 50 | 55 |
| New York | 66 | 60 | 55 | 61 | 45 | 38 | 40 | 43 | 45 | 47 |
| New Jersey | 65 | 58 | 52 | 54 | 42 | 36 | 38 | 40 | 40 | 45 |
| Pennsylvania | 57 | 57 | 49 | 55 | 39 | 33 | 34 | 40 | 41 | 45 |
| Delaware | 55 | 44 | 40 | 45 | 34 | 25 | 30 | 31 | 34 | 38 |
| Maryland | 53 | 45 | 44 | 50 | 37 | 32 | 30 | 35 | 36 | 41 |
| Virginia | 50 | 53 | 46 | 47 | 37 | 32 | 38 | 35 | 38 | 49 |
| North Carolina | 58 | 54 | 50 | 47 | 38 | 37 | 43 | 43 | 47 | 57 |
| South Carolina | 70 | 57 | 60 | 65 | 46 | 46 | 49 | 46 | 50 | 64 |
| Georgia | 69 | 56 | 56 | 58 | 41 | 43 | 48 | 48 | 50 | 57 |
| Florida | 80 | 60 | 68 | 71 | 47 | 53 | 55 | 50 | 53 | 60 |
| Alabama | 63 | 52 | 59 | 53 | 37 | 45 | 46 | 41 | 47 | 58 |
| Mississippi | 58 | 51 | 55 | 49 | 37 | 44 | 45 | 39 | 46 | 58 |
| Louisiana | 60 | 50 | 57 | 62 | 40 | 45 | 45 | 41 | 44 | 50 |
| Texas | 55 | 45 | 54 | 56 | 31 | 41 | 41 | 34 | 36 | 47 |
| Arkansas | 46 | 47 | 45 | 47 | 32 | 37 | 40 | 29 | 38 | 43 |
| Tennessee | 43 | 43 | 39 | 39 | 27 | 28 | 36 | 29 | 39 | 49 |
| West Virginia | 52 | 56 | 55 | 57 | 40 | 34 | 40 | 37 | 45 | 50 |
| Kentucky | 40 | 40 | 43 | 44 | 27 | 25 | 35 | 27 | 37 | 40 |
| Ohio | 41 | 42 | 40 | 43 | 27 | 21 | 25 | 27 | 30 | 34 |

*Average farm price of corn per bushel in the United States December 1, 1891–1900, by States*—Continued.

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| Michigan | 48 | 46 | 45 | 50 | 32 | 24 | 27 | 34 | 36 | 37 |
| Indiana | 38 | 40 | 36 | 37 | 23 | 19 | 21 | 25 | 27 | 32 |
| Illinois | 37 | 37 | 31 | 39 | 22 | 18 | 21 | 25 | 26 | 32 |
| Wisconsin | 44 | 38 | 35 | 45 | 30 | 22 | 25 | 28 | 30 | 33 |
| Minnesota | 39 | 37 | 34 | 43 | 20 | 19 | 24 | 24 | 24 | 29 |
| Iowa | 30 | 32 | 27 | 45 | 18 | 14 | 17 | 23 | 23 | 27 |
| Missouri | 38 | 36 | 30 | 40 | 20 | 20 | 24 | 27 | 30 | 32 |
| Kansas | 34 | 31 | 31 | 43 | 19 | 18 | 22 | 26 | 25 | 32 |
| Nebraska | 26 | 28 | 27 | 50 | 18 | 13 | 17 | 22 | 23 | 31 |
| South Dakota | 35 | 33 | 25 | 46 | 23 | 18 | 21 | 23 | 26 | 29 |
| North Dakota | 40 | 40 | 38 | 44 | 24 | 25 | 32 | 36 | 33 | 42 |
| Montana | ...... | 70 | 70 | 82 | 75 | 60 | 65 | 66 | 52 | 59 |
| Wyoming | ...... | 61 | 63 | 65 | 57 | 78 | 50 | 55 | 43 | 60 |
| Colorado | 53 | 40 | 51 | 61 | 41 | 36 | 38 | 40 | 43 | 48 |
| New Mexico | 72 | 72 | 71 | 75 | 56 | 55 | 58 | 56 | 58 | 64 |
| Utah | 60 | 58 | 58 | 58 | 49 | 51 | 55 | 60 | 59 | 63 |
| Washington | ...... | 60 | 62 | 69 | 40 | 57 | 55 | 42 | 55 | 59 |
| Oregon | 71 | 56 | 47 | 56 | 55 | 56 | 53 | 60 | 64 | 57 |
| California | 71 | 55 | 50 | 57 | 53 | 53 | 56 | 62 | 60 | 61 |
| Oklahoma | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 20 | 26 |
| General average | 40.60 | 39.43 | 36.53 | 45.74 | 25.33 | 21.50 | 26.33 | 28.69 | 30.28 | 35.70 |

## Saving of Seed Corn.

The best plan for saving corn for seed is to go through the field before the crop is harvested and gather the best ears from the best stalks. The largest yields of grain are usually made from varieties producing two ears on each stalk, and if such a variety is desired then seed should be saved only from stalks bearing two ears. It is sometimes claimed that the upper one of two ears will produce the earlier maturing crop, but unless early maturity is of considerable importance, if a stalk has two good ears both should be taken; if one ear is good and the other only fair the better one may be taken; while if either ear is very poor in size, shape, or fullness both should be rejected. If a variety bearing only one ear to each stalk is preferred the ears selected for seed should be the largest which can be found, of nearly equal diameter throughout, and well filled at each end. It is as important to take seed from the best stalks as from the best ears, and whatever variety may be preferred every ear which is selected for seed should be taken from a stalk which in size, habit of growth, and number of ears approaches closely to what is the desired form for that variety.

If careful hands are employed in gathering the crop a very good selection of seed may be made by having a box in the wagon into which the most desirable ears may be thrown as they are found.

In selecting seed from the crib, as is often done, nothing can be known of the character of the stalks upon which the ears were grown, and little or no improvement can be made in a variety by such a selection; while a careful and judicious selection in the field will work a constant and gradual improvement in the crop and will make it more nearly uniform with each succeeding year. No one item in the growing of corn is of greater importance than the selection of seed.

After the seed has been selected it should be thoroughly dried, treated with bisulphid of carbon to destroy insects, and then stored where it will be kept dry and secure from rats and mice.

It is a somewhat common practice to discard the tips and butts of the ears when shelling the seed for planting, but the practice is of doubtful benefit. A number of the experiment stations in both the North and the South have made repeated tests of the productiveness of seed from different parts of the ear, but these tests have shown no marked or constant differences in yield, even when the selections have been repeated through several generations.

For all ordinary purposes the value of a variety depends on the amount of shelled corn which it will produce per acre. This in turn depends fully as much on the growth and productiveness of the individual stalks as upon the size and shape of the separate ears, and for that reason seed should always be selected in the field rather than from the crib.

*Wholesale prices of corn per bushel in leading cities of the United States, 1896–1900.*

| Date. | New York. | | Baltimore. | | Cincinnati. | | Chicago. | | Detroit. | | St. Louis. | | San Francisco. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. 2. | | No. 2. | | No. 2. | | No. 2. | | No. 2. | | No. 2. | | No. 1, white (per cwt.). | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | | |
| January | 34⅜ | 37 | 31¾ | 34 | 27½ | 30 | 25½ | 28¼ | 27½ | 29¼ | 23⅞ | 26⅝ | $0.83¾ | $0.85 |
| February | 36 | 37¾ | 32½ | 35 | 29½ | 31 | 27¾ | 29 | 28 | 30 | 26 | 27⅜ | .81¼ | .85 |
| March | 37 | 40 | 33¼ | 36½ | 29½ | 31 | 28⅛ | 29¼ | 29 | 30½ | 26 | 27¼ | .82½ | .83¾ |
| April | 35⅜ | 41 | 34½ | 36 | 31 | 32¼ | 28¾ | 30⅝ | 28½ | 32 | 25¾ | 27¾ | .85 | .91¼ |
| May | 33½ | 35¾ | 33 | 36 | 30 | 32½ | 27½ | 29½ | 28 | 28½ | 25¼ | 27¼ | .85 | .90 |
| June | 33 | 34¼ | 33 | 36½ | 29 | 30 | 26¼ | 28½ | 27 | 29 | 24⅝ | 26⅛ | .82½ | .83¾ |
| July | 30⅜ | 34 | 30 | 35 | 27½ | 30½ | 24¼ | 27¾ | 25 | 29 | 22 | 25½ | .80 | .80 |
| August | 26¼ | 31¼ | 26¼ | 31 | 24 | 27½ | 20½ | 25 | 22½ | 26½ | 18½ | 22¾ | .77½ | .81¼ |
| September | 25¼ | 27⅝ | 26 | 30 | 22½ | 26 | 19½ | 22¼ | 20½ | 24½ | 17¾ | 21 | .75 | .77½ |
| October | 28 | 34¼ | 27 | 35½ | 26 | 30 | 22¼ | 26½ | 24½ | 30 | 21 | 24¼ | .78¾ | .87½ |
| November | 28⅜ | 31¾ | 23½ | 30½ | 22 | 27 | 22¾ | 25½ | 22 | 25 | 21¼ | 23½ | .87½ | .90 |
| December | 28⅜ | 29¾ | 22 | 30 | 22 | 24 | 22½ | 23¾ | 20½ | 22 | 19⅞ | 21½ | .85 | .87½ |
| **1897.** | | | | | | | | | | | | | | |
| January | 28¼ | 29¾ | 22 | 28¼ | 22½ | 24 | 21¾ | 23⅜ | 21½ | 23 | 19¼ | 20¾ | .77½ | .87½ |
| February | 28 | 29⅜ | 26 | 29 | 23½ | 25 | 21¾ | 23¼ | 21½ | 23½ | 19½ | 20½ | .77½ | .82½ |
| March | 27 | 30½ | 26½ | 31 | 24 | 25½ | 22¾ | 24½ | 23 | 25 | 20⅛ | 21½ | .80 | .85 |
| April | 28¾ | 30¾ | 28½ | 31 | 25 | 30 | 23⅛ | 25¼ | 24 | 26 | 20½ | 22¾ | .81¼ | .85 |
| May | 29 | 30⅞ | 31 | 34 | 26½ | 31 | 23 | 25½ | 23 | 27 | 20⅜ | 24 | .82½ | .97½ |
| June | 28½ | 30 | 30 | 33 | 26 | 27½ | 23¼ | 25⅝ | 24 | 27 | 21½ | 23½ | .90 | .97½ |
| July | 28½ | 33⅜ | 30 | 35 | 27½ | 29½ | 24⅝ | 28¼ | 26½ | 28½ | 21½ | 25½ | .90 | .97½ |
| August | 31¼ | 38 | 34 | 38 | 28¾ | 33 | 26⅛ | 32⅝ | 28½ | 32½ | 25 | 27¾ | 1.05 | 1.10 |
| September | 32 | 37½ | 36 | 39 | 30½ | 33½ | 27¼ | 32 | 30 | 32½ | 25 | 29½ | 1.07½ | 1.12½ |
| October | 29⅜ | 33½ | 31 | 37½ | 26½ | 31 | 24 | 29 | 24½ | 31 | 24 | 27½ | 1.10 | 1.12½ |
| November | 30⅝ | 32¾ | 30 | 35½ | 26 | 28½ | 25¾ | 27⅝ | 25¾ | 26½ | 24⅜ | 26⅛ | .90 | .97½ |
| December | 31¼ | 34 | 27½ | 35½ | 27 | 30 | 25 | 27½ | 26½ | 30½ | 24 | 26¼ | .90 | .92½ |
| **1898.** | | | | | | | | | | | | | | |
| January | 33 | 35½ | 29 | 35¾ | 29 | 30 | 26 | 28¼ | 28½ | 30 | 25¼ | 26¾ | .85 | .97½ |
| February | 34¼ | 37¼ | 32 | 36 | 29½ | 32 | 27¼ | 30⅝ | 28¾ | 33½ | 26 | 28½ | .97½ | 1.10 |
| March | 34¼ | 36¼ | 32½ | 35 | 31⅝ | 32¼ | 28⅛ | 29¾ | 29½ | 32 | 26½ | 27⅞ | 1.05 | 1.12½ |
| April | 34⅜ | 40⅝ | 34 | 42 | 31½ | 38 | 28⅞ | 35¼ | 31 | 36½ | 27 | 32¾ | 1.10 | 1.15 |
| May | 36¾ | 41⅞ | 36¾ | 42½ | 37 | 40 | 32⅜ | 37 | 35 | 39½ | 32 | 35½ | 1.10 | 1.12½ |
| June | 35⅛ | 38⅝ | 35½ | 37½ | 34¼ | 36 | 31 | 33¾ | 31¾ | 36 | 30 | 32½ | 1.05 | 1.12½ |
| July | 35½ | 38¾ | 35 | 42 | 34½ | 37½ | 31¾ | 35½ | 32 | 36 | 30½ | 33¾ | 1.07½ | 1.12½ |
| August | 35 | 38 | 33 | 41 | 31 | 36½ | 29¾ | 33¾ | 32 | 35½ | 28¼ | 33 | 1.10 | 1.17½ |
| September | 34 | 35½ | 34 | 36½ | 31 | 31½ | 29⅛ | 31⅜ | 30½ | 32½ | 28½ | 29⅝ | 1.12½ | 1.15 |
| October | 34¼ | 38¾ | 34 | 38 | 31 | 35 | 28¾ | 32⅞ | 30 | 35½ | 29 | 32½ | 1.05 | 1.15 |
| November | 37½ | 39¼ | 32 | 39 | 34 | 37 | 31⅝ | 34½ | 34 | 36 | 30 | 32¼ | 1.05 | 1.07½ |
| December | 38⅞ | 44¼ | 36 | 43½ | 34 | 38½ | 33⅛ | 38 | 34 | 38 | 31¾ | 36½ | 1.05 | 1.15 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1899.** | | | | | | | | | | | | | | |
| January | 41⅜ | 45⅝ | 39½ | 41⅝ | 35½ | 38 | 35¼ | 38⅛ | 37 | 38 | 34¾ | 36¼ | 1.12 | 1.15 |
| February | 42¼ | 45 | 37¾ | 42 | 33 | 37 | 33½ | 37 | 35½ | 37 | 33 | 35 | Nominal. | |
| March | 41 | 45⅛ | 36 | 39⅜ | 35 | 37½ | 33 | 36⅛ | 34½ | 36½ | 33 | 34¾ | Nominal. | |
| April | 41 | 45½ | 38 | 43 | 36½ | 37½ | 34 | 35½ | 35½ | 37½ | 33½ | 35 | 1.15 | 1.17½ |
| May | 39¼ | 43½ | 36¾ | 38¾ | 34 | 36½ | 32½ | 34⅜ | 34½ | 35½ | 31½ | 34½ | 1.17½ | 1.17½ |
| June | 40⅛ | 42⅝ | 37 | 39½ | 35 | 36½ | 33¼ | 35½ | 34½ | 35 | 32 | 33½ | 1.15 | 1.17½ |
| July | 37⅜ | 41½ | 35 | 38¾ | 35 | 36½ | 31 | 34⅞ | 34 | 35½ | 31½ | 33½ | 1.15 | 1.15 |
| August | 36½ | 41¼ | 34¾ | 37½ | 32 | 34½ | 30½ | 33 | 33½ | 35 | 30 | 31½ | 1.07½ | 1.12½ |
| September | 38⅝ | 41⅝ | 36½ | 40½ | 33¾ | 35 | 31¼ | 35 | 33¼ | 35½ | 30 | 31 | 1.07½ | 1.07½ |
| October | 39¾ | 42⅜ | 37½ | 39¼ | 34 | 36 | 31 | 33 | 34½ | 36½ | 30½ | 31¾ | Nominal. | |
| November | 39⅝ | 41¾ | 37½ | 39¾ | 31½ | 35 | 30¾ | 33¼ | 33 | 35½ | 30 | 31½ | Nominal. | |
| December | 39⅜ | 40⅞ | 36⅜ | 38⅜ | 31½ | 34 | 30 | 31½ | 32 | 33½ | 29½ | 31 | 1.05 | 1.05 |
| **1900.** | | | Mixed. | | | | | | | | | | | |
| January | 39⅞ | 42¼ | 36⅝ | 37¾ | 32¾ | 36 | 30½ | 31⅝ | 32½ | 34 | 30½ | 31 | 1.00 | 1.00 |
| February | 39⅞ | 44⅛ | 36¾ | 40⅜ | 33¼ | 36 | 31½ | 34¼ | 33½ | 35½ | 30½ | 33½ | 1.00 | 1.00 |
| March | 40⅞ | 46 | 38 | 42⅞ | 36 | 40¾ | 33⅜ | 38¼ | 36 | 40½ | 33½ | 37½ | 1.02½ | 1.10 |
| April | 45¾ | 49¾ | 42⅝ | 45½ | 41 | 43½ | 38¼ | 40⅞ | 40 | 43½ | 37½ | 39¾ | 1.07½ | 1.10 |
| May | 41 | 47½ | 40⅝ | 45 | 40½ | 44 | 36 | 40½ | 39¼ | 41 | 36⅜ | 40½ | 1.02½ | 1.07½ |
| June | 42¾ | 50⅝ | 41⅝ | 48 | 39¾ | 45 | 37⅜ | 43½ | 39¾ | 45 | 37 | 42 | 1.02½ | 1.17½ |
| July | 44 | 52⅛ | 42⅜ | 48¾ | 41½ | 47 | 38⅜ | 44¾ | 40¾ | 45 | 37½ | 43 | 1.17½ | 1.17½ |
| August | 42⅞ | 47¾ | 41¾ | 45 | 41 | 43 | 37¼ | 41¼ | 42½ | 43¾ | 37½ | 40 | 1.22½ | 1.30 |
| September | 45 | 50⅜ | 44¼ | 47 | 42½ | 44 | 38⅞ | 43¼ | 43½ | 44 | 38¾ | 40½ | Nominal. | |
| October | 46 | 49¾ | 42 | 47 | 37 | 43 | 36½ | 41¾ | 41 | 43½ | 34 | 39 | 1.25 | 1.27½ |
| November | 45¾ | 47½ | 42¼ | 44½ | 37 | 40 | 35 | 49½ | 38¾ | 41 | 34¼ | 35¾ | 1.20 | 1.25 |
| December | 44¾ | 48 | 41⅞ | 44¼ | 37¾ | 39½ | 35¼ | 40½ | 38 | 39½ | 33¾ | 36 | 1.20 | 1.20 |

*Transportation rates, average for corn, in cents, St. Louis to New Orleans by river.*

| Year. | Per bushel. | | Year. | Per bushel. | | Sacks, per 100 lbs. | Year. | Per bushel. | | Sacks, per 100 lbs. | Year. | Sacks, per 100 lbs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low water. | High water. | | Low water. | High water. | | | Low water. | High water. | | | |
| 1866... | 9.05 | 10.93 | 1875.. | 4.87 | 10.01 | ....... | 1884..... | 5.00 | 7.00 | 14.00 | 1893..... | 17.54 |
| 1867... | 11.09 | 14.83 | 1876.. | 5.02 | 11.30 | ....... | 1885..... | 5.00 | 7.00 | 15.00 | 1894..... | 17.14 |
| 1868... | 6.23 | 9.84 | 1877.. | 7.63 | 8.59 | 20.04 | 1886..... | 5.00 | 7.00 | 16.00 | 1895..... | 12.50 |
| 1869... | 6.32 | 8.42 | 1878.. | 4.96 | 8.93 | 17.36 | 1887..... | 5.00 | 7.00 | 18.25 | 1896..... | 14.55 |
| 1870... | 9.23 | 13.66 | 1879.. | 5.00 | 11.00 | 18.00 | 1888..... | 5.00 | 7.50 | 15.00 | 1897..... | 15.00 |
| 1871... | 6.71 | 16.29 | 1880.. | 7.00 | 9.50 | 19.00 | 1889..... | 5.00 | 7.00 | 17.93 | 1898..... | 10.00 |
| 1872... | 9.79 | 19.04 | 1881.. | 4.00 | 8.00 | 20.00 | 1890..... | 5.00 | 7.00 | 15.66 | 1899..... | 10.00 |
| 1873... | 6.15 | 9.67 | 1882.. | 5.50 | 7.00 | 20.00 | 1891..... | 5.00 | 7.50 | 16.07 | 1900..... | 10.00 |
| 1874... | 4.95 | 8.09 | 1883.. | 5.00 | 7.00 | 17.75 | 1892..... | 5.00 | 7.00 | 16.87 | | |

## WHEAT.

The wheat crop of the world for 1900 was nearly 167,000,000 bushels, about 6 per cent, short of the preceding crop and about 341,000,000 bushels below the big total of 1898. It exceeded the crops of 1896 and 1897, the latter by 367,000,000 bushels.

Of the world's crop in 1900 the United States supplied 522,230,000 bushels, more than 100,000,000 bushels in excess of the crop of any other single country, but 25,000,000 bushels less than the United States crop of 1899, and 153,000,000 short of the great crop of 1898. The falling off was mainly in the States of Ohio, Indiana, North Dakota, South Dakota, Minnesota, Michigan, California, and Oregon, running from 4,000,000 bushels in Michigan to 38,500,000 in North Dakota. There were important increases in total yields in Kansas, where there was a jump from 36,400,000 bushels to 82,400,000, in Texas, Tennessee, Kentucky, Maryland, Virginia, Illinois, Wisconsin, Iowa, Missouri, Nebraska, and Washington.

The decrease of 2,000,000 acres in the total acreage of the country corresponded almost exactly with the decrease in the total crop, the yield per acre being the same for both years, 12.3 bushels. Also the falling off in total yield in the great wheat States mentioned accompanied a lowering of the acreage in every instance, while the increase in Kansas followed an increase of nearly a million acres harvested, and a similar relation was maintained in the other States. There were, however, very notable increases in yield per acre in Nebraska, Kansas, Illinois, Iowa, Missouri, Kentucky, Virginia, Maryland, Texas, and Oklahoma, while decreases are noted for Minnesota, the Dakotas, Oregon, California, Ohio, and Indiana.

The average value per acre for the United States in 1900 was $7.61, against $7.17 in 1899. The variations in value per acre through the States follow very closely the changes in yield per acre.

Farm prices varied not very much from 1899. There was a good advance, 5 to 7 cents, in the great wheat States, where a falling off in the crop has been noted, except in California, where the figures went from 62 cents a bushel to 58 cents, and Oregon, where the advance was only 2 cents. There was less change where the increased crops have been noted, but the advance of 3 cents in Kansas on the great crop there made a large addition to the total value for the State.

The wholesale prices in Chicago went from $61\frac{1}{2}$ in January to $74\frac{5}{8}$ in December, with a maximum of $87\frac{1}{2}$ cents in June. After July the price was pretty steadily maintained in the neighborhood of 70 to 74 cents.

Transportation rates by river, St. Louis to New Orleans, for sacks were practically unchanged.

The exports for 1900 amounted to 101,950,389 bushels, worth $73,237,080, against 139,432,815 bushels in 1899, worth $104,269,169. The export price, 71.8 cents per bushel, was 3 cents lower than in 1899. The exports of flour footed up 18,699,194 barrels, an increase of 213,504 barrels over last year, but the price declined from $3.95 a barrel to $3.62, with a consequent decrease in the total return for flour of $5,332,984. But in spite of this falling off of $36,365,073 in the income to the United States for wheat and flour in 1900 as compared with 1899, the showing was near the average for the past five years, as appears in the export tables, pages 849.

*Wheat crop of the world, 1896–1900.*

| Countries. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| United States | 427,684,000 | 530,149,000 | 675,149,000 | 547,304,000 | 522,230,000 |
| Ontario | 19,184,000 | 29,765,000 | 33,042,000 | 22,158,000 | 24,106,000 |
| Manitoba | 14,825,000 | 18,837,000 | 26,112,000 | 28,802,000 | 13,436,000 |
| Rest of Canada | 6,800,000 | 7,500,000 | 9,000,000 | 9,000,000 | 7,000,000 |
| Total Canada | 40,809,000 | 56,102,000 | 68,154,000 | 59,960,000 | 44,542,000 |
| Mexico | 22,555,000 | 9,700,000 | 8,789,000 | 12,000,000 | 15,000,000 |
| Total North America | 491,048,000 | 595,951,000 | 752,092,000 | 619,264,000 | 581,772,000 |
| Chile | 12,000,000 | 10,500,000 | 14,000,000 | 13,000,000 | 12,000,000 |
| Argentina | 41,433,000 | 25,410,000 | 46,603,000 | 104,982,000 | 101,266,000 |
| Uruguay | 4,059,000 | 3,600,000 | 6,000,000 | 7,164,000 | 6,891,000 |
| Total South America | 57,492,000 | 39,510,000 | 66,603,000 | 125,146,000 | 120,157,000 |
| Great Britain | 58,851,000 | 56,672,000 | 75,330,000 | 67,594,000 | 55,330,000 |
| Ireland | 1,194,000 | 1,355,000 | 1,856,000 | 1,786,000 | 1,735,000 |
| Total United Kingdom | 60,045,000 | 58,027,000 | 77,186,000 | 69,380,000 | 57,065,000 |
| Norway | 300,000 | 300,000 | 300,000 | 260,000 | 300,000 |
| Sweden | 4,704,000 | 4,678,000 | 4,542,000 | 4,430,000 | 5,249,000 |
| Denmark | 3,689,000 | 3,474,000 | 2,991,000 | 3,654,000 | 3,500,000 |
| Netherlands | 5,045,000 | 4,290,000 | 5,406,000 | 4,300,000 | 4,300,000 |
| Belgium | 13,748,000 | 11,967,000 | 13,810,000 | 12,400,000 | 12,000,000 |
| France | 339,793,000 | 246,596,000 | 363,498,000 | 364,414,000 | 309,383,000 |
| Spain | 71,892,000 | 93,194,000 | 123,865,000 | 100,759,000 | 105,000,000 |
| Portugal | 5,600,000 | 8,200,000 | 7,800,000 | 6,400,000 | 8,000,000 |
| Italy | 145,233,000 | 86,919,000 | 137,345,000 | 137,912,000 | 119,750,000 |
| Switzerland | 4,800,000 | 4,300,000 | 4,500,000 | 4,200,000 | 4,500,000 |
| Germany | 125,661,000 | 119,903,000 | 132,557,000 | 141,369,000 | 141,139,000 |
| Austria | 44,004,000 | 35,859,000 | 47,357,000 | 51,522,000 | 42,500,000 |
| Hungary | 149,954,000 | 83,590,000 | 128,225,000 | 141,735,000 | 137,000,000 |
| Croatia-Slavonia | 9,614,000 | 6,271,000 | 11,323,000 | 9,068,000 | 8,400,000 |
| Bosnia-Herzegovina | 2,050,000 | 1,484,000 | 2,297,000 | 2,000,000 | 1,750,000 |
| Total Austria-Hungary | 205,622,000 | 127,204,000 | 189,202,000 | 204,325,000 | 189,650,000 |
| Roumania | 71,194,000 | 36,448,000 | 58,457,000 | 26,064,000 | 56,463,000 |
| Bulgaria | 48,275,000 | 30,739,000 | 33,993,000 | 21,630,000 | 30,000,000 |
| Servia | 9,300,000 | 13,392,000 | 11,000,000 | 9,000,000 | 10,000,000 |
| Montenegro | 220,000 | 200,000 | 220,000 | 200,000 | 220,000 |
| Turkey in Europe | 24,000,000 | 17,800,000 | 25,000,000 | 15,000,000 | 20,000,000 |
| Greece | 4,800,000 | 3,200,000 | 4,000,000 | 2,500,000 | 3,000,000 |
| Russia proper | 300,423,000 | 238,557,000 | 334,246,000 | 314,876,000 | 319,193,000 |
| Poland | 19,476,000 | 17,808,000 | 21,691,000 | 21,544,000 | 19,722,000 |
| North Caucasus | 45,148,000 | 29,883,000 | 52,251,000 | 57,313,000 | 56,948,000 |
| Finland | 98,000 | 90,000 | 100,000 | 90,000 | 90,000 |
| Total Russia in Europe | 365,145,000 | 286,338,000 | 408,288,000 | 393,823,000 | 395,953,000 |
| Total Europe | 1,509,066,000 | 1,157,169,000 | 1,603,960,000 | 1,522,020,000 | 1,475,472,000 |
| Siberia | 34,160,000 | 42,835,000 | 36,157,000 | 45,473,000 | 20,172,000 |
| Central Asia | 12,830,000 | 11,087,000 | 14,944,000 | 14,938,000 | 6,959,000 |
| Trans-Caucasia | 42,000,000 | 40,000,000 | 40,000,000 | 33,000,000 | 35,000,000 |
| Total Russia in Asia | 88,990,000 | 93,922,000 | 91,101,000 | 93,411,000 | 62,131,000 |
| Turkey in Asia | 44,000,000 | 48,000,000 | 44,000,000 | 35,200,000 | 30,000,000 |
| Cyprus | 2,400,000 | 2,400,000 | 2,400,000 | 2,000,000 | 2,400,000 |
| Persia | 20,000,000 | 20,000,000 | 17,600,000 | 16,000,000 | 16,000,000 |
| British India | 205,743,000 | 191,257,000 | 259,670,000 | 236,679,000 | 182,582,000 |
| Japan | 18,187,000 | 19,509,000 | 21,407,000 | 20,000,000 | 20,000,000 |
| Total Asia | 379,320,000 | 375,088,000 | 436,178,000 | 403,290,000 | 313,113,000 |
| Algeria | 23,631,000 | 19,891,000 | 27,114,000 | 22,282,000 | 23,000,000 |
| Tunis | 5,600,000 | 5,000,000 | 6,500,000 | 4,800,000 | 6,400,000 |
| Egypt | 12,000,000 | 12,000,000 | 13,000,000 | 13,000,000 | 14,000,000 |
| Cape Colony | 2,257,000 | 2,200,000 | 2,012,000 | 2,291,000 | 2,000,000 |
| Total Africa | 43,488,000 | 39,091,000 | 48,626,000 | 42,373,000 | 45,400,000 |

*Wheat crop of the world, 1896–1900*—Continued.

| Countries. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| West Australia | 194,000 | 252,000 | 421,000 | 892,000 | 1,018,000 |
| South Australia | 6,616,000 | 2,893,000 | 4,141,000 | 9,056,000 | 8,720,000 |
| Queensland | 128,000 | 620,000 | 1,041,000 | 626,000 | 634,000 |
| New South Wales | 5,359,000 | 9,132,000 | 10,893,000 | 9,569,000 | 14,033,000 |
| Victoria | 5,848,000 | 7,315,000 | 10,914,000 | 20,198,000 | 15,718,000 |
| Tasmania | 1,202,000 | 1,327,000 | 1,721,000 | 2,376,000 | 1,136,000 |
| New Zealand | 7,059,000 | 6,113,000 | 5,849,000 | 13,485,000 | 8,852,000 |
| Total Australasia | 25,906,000 | 27,652,000 | 34,980,000 | 56,202,000 | 50,111,000 |

RECAPITULATION BY CONTINENTS.

| | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|
| North America | 491,048,000 | 595,951,000 | 752,092,000 | 619,264,000 | 581,772,000 |
| South America | 57,492,000 | 39,510,000 | 66,603,000 | 125,146,000 | 120,157,000 |
| Europe | 1,509,066,000 | 1,157,169,000 | 1,603,960,000 | 1,522,020,000 | 1,475,472,000 |
| Asia | 379,320,000 | 375,088,000 | 436,178,000 | 403,290,000 | 313,113,000 |
| Africa | 43,488,000 | 39,091,000 | 48,626,000 | 42,373,000 | 45,400,000 |
| Australasia | 25,906,000 | 27,652,000 | 34,980,000 | 56,202,000 | 50,111,000 |
| Total | 2,506,320,000 | 2,234,461,000 | 2,942,439,000 | 2,768,295,000 | 2,586,025,000 |

*World's visible supply of wheat the first of each month for ten years.*

| Month. | 1891–1892. | 1892–1893. | 1893–1894. | 1894–1895. | 1895–1896. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| July | .............. | 132,100,000 | 183,700,000 | 172,600,000 | 160,300,000 |
| August | 109,600,000 | 122,900,000 | 178,200,000 | 174,500,000 | 158,000,000 |
| September | 112,200,000 | 145,700,000 | 182,900,000 | 189,500,000 | 152,200,000 |
| October | 155,200,000 | 166,300,000 | 195,700,000 | 205,200,000 | 176,500,000 |
| November | 179,000,000 | 196,200,000 | 220,600,000 | 220,800,000 | 209,800,000 |
| December | 203,000,000 | 231,500,000 | 237,500,000 | 218,800,000 | 218,700,000 |
| January | 199,600,000 | 237,400,000 | 232,000,000 | 227,800,000 | 224,700,000 |
| February | 197,300,000 | 234,200,000 | 232,900,000 | 223,000,000 | 202,800,000 |
| March | 181,400,000 | 229,300,000 | 222,400,000 | 212,400,000 | 191,900,000 |
| April | 187,300,000 | 221,600,000 | 216,500,000 | 198,200,000 | 180,600,000 |
| May | 161,300,000 | 215,500,000 | 206,900,000 | 186,500,000 | 161,100,000 |
| June | 147,800,000 | 205,000,000 | 195,700,000 | 171,100,000 | 147,500,000 |

| Month. | 1896–1897. | 1897–1898. | 1898–1899. | 1899–1900. | 1900–1901. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| July | 137,400,000 | 88,700,000 | 86,700,000 | 140,200,000 | 149,800,000 |
| August | 124,200,000 | 77,500,000 | 70,100,000 | 134,500,000 | 150,100,000 |
| September | 126,400,000 | 87,000,000 | 66,500,000 | 142,500,000 | 164,600,000 |
| October | 151,200,000 | 119,100,000 | 83,000,000 | 162,800,000 | 188,200,000 |
| November | 190,500,000 | 139,300,000 | 106,800,000 | 191,100,000 | 200,800,000 |
| December | 202,300,000 | 156,000,000 | 135,800,000 | 203,400,000 | 208,200,000 |
| January | 184,600,000 | 157,000,000 | 147,100,000 | 202,700,000 | 200,500,000 |
| February | 173,400,000 | 151,700,000 | 146,400,000 | 190,500,000 | .............. |
| March | 155,500,000 | 140,500,000 | 151,100,000 | 181,500,000 | .............. |
| April | 139,000,000 | 132,000,000 | 144,900,000 | 184,100,000 | .............. |
| May | 121,400,000 | 111,200,000 | 139,500,000 | 175,700,000 | .............. |
| June | 106,900,000 | 109,800,000 | 136,900,000 | 157,400,000 | .............. |

*Statement showing world's export shipments of wheat and flour for five years.*

| | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| America | 152,639,000 | 182,829,000 | 230,390,000 | 207,490,000 | 189,820,000 |
| Russia | 123,118,000 | 118,546,000 | 102,864,000 | 61,141,000 | 67,460,000 |
| Danubian | 59,603,000 | 15,682,000 | 14,952,000 | 14,410,000 | 36,824,000 |
| Argentina | 18,200,000 | 1,808,000 | 22,984,000 | 61,720,000 | 72,002,000 |
| India | 4,608,000 | 1,688,000 | 33,488,000 | 23,160,000 | 12,000 |
| Australia | 368,000 | .............. | 142,000 | 10,155,000 | 7,188,000 |
| Total | 358,536,000 | 320,553,000 | 404,820,000 | 378,076,000 | 373,306,000 |

*Visible supplies of wheat in the United States and Canada first of each month for ten years.*

EAST OF ROCKY MOUNTAINS.[1]

| Month. | 1891-1892. | 1892-1893. | 1893-1894. | 1894-1895. | 1895-1896. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| July | 21,054,526 | 33,287,425 | 75,366,000 | 65,250,000 | 53,568,000 |
| August | 22,692,000 | 31,310,000 | 69,889,000 | 69,766,000 | 46,767,000 |
| September | 25,048,048 | 42,875,432 | 64,823,000 | 79,826,000 | 44,732,000 |
| October | 36,577,055 | 59,845,134 | 71,108,000 | 92,100,000 | 55,078,000 |
| November | 50,524,454 | 78,624,535 | 83,265,000 | 108,072,000 | 75,598,000 |
| December | 62,328,852 | 94,671,258 | 96,597,000 | 113,116,000 | 87,688,000 |
| January | 69,213,601 | 107,057,000 | 99,542,000 | 113,707,000 | 97,769,000 |
| February | 66,544,558 | 111,905,000 | 98,836,000 | 106,917,000 | 97,592,000 |
| March | 64,377,444 | 109,370,000 | 93,926,000 | 98,745,000 | 94,538,000 |
| April | 59,732,451 | 108,391,000 | 89,362,000 | 91,286,000 | 90,442,000 |
| May | 40,382,838 | 101,360,000 | 82,085,000 | 80,454,000 | 80,390,000 |
| June | 30,248,805 | 90,681,000 | 71,816,000 | 64,375,000 | 68,773,000 |

| Month. | 1896-1897. | 1897-1898. | 1898-1899. | 1899-1900. | 1900-1901. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| July | 61,354,000 | 27,090,000 | 18,069,000 | 46,870,000 | 58,523,000 |
| August | 58,414,000 | 23,793,000 | 12,325,000 | 48,622,000 | 60,398,000 |
| September | 57,588,000 | 20,073,000 | 11,499,000 | 48,087,000 | 66,240,000 |
| October | 63,955,000 | 31,508,000 | 22,857,000 | 60,040,000 | 76,071,000 |
| November | 76,716,000 | 42,609,000 | 31,864,000 | 77,195,000 | 82,238,000 |
| December | 76,433,000 | 50,059,000 | 45,914,000 | 84,687,000 | 86,591,000 |
| January | 73,270,000 | 54,173,000 | 50,126,000 | 89,265,000 | 87,911,000 |
| February | 68,092,000 | 51,105,000 | 51,648,000 | 87,473,000 | 86,324,000 |
| March | 61,624,000 | 46,532,000 | 51,085,000 | 85,570,000 | 80,704,000 |
| April | 55,946,000 | 40,901,000 | 51,238,000 | 79,690,000 | 75,501,000 |
| May | 49,684,000 | 31,039,000 | 47,258,000 | 70,764,000 | ............ |
| June | 37,975,000 | 29,226,000 | 42,092,000 | 57,617,000 | ............ |

[1] The figures for stocks east of the Rocky Mountains represent 62 principal points of accumulation including the Manitoba elevators and stocks afloat on lakes and canals.

PACIFIC COAST.

| Month. | 1891-1892. | 1892-1893. | 1893-1894. | 1894-1895. | 1895-1896. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| July | 1,981,000 | 2,372,000 | 2,842,000 | 8,253,000 | 6,549,000 |
| August | 2,044,000 | 2,770,000 | 4,487,000 | 8,321,000 | 4,762,000 |
| September | 3,403,000 | 3,589,000 | 6,114,000 | 8,532,000 | 8,799,000 |
| October | 9,517,000 | 8,153,000 | 7,162,000 | 9,074,000 | 9,760,000 |
| November | 12,752,000 | 8,714,000 | 7,760,000 | 13,130,000 | 9,651,000 |
| December | 10,619,000 | 10,415,000 | 10,629,000 | 14,582,000 | 8,276,000 |
| January | 8,843,000 | 9,305,000 | 10,721,000 | 13,302,000 | 7,116,000 |
| February | 6,043,000 | 6,457,000 | 9,859,000 | 13,118,000 | 5,859,000 |
| March | 3,443,596 | 5,300,000 | 9,622,000 | 11,801,000 | 4,296,000 |
| April | 2,607,000 | 4,788,000 | 9,005,000 | 10,456,000 | 3,822,000 |
| May | 2,488,000 | 3,546,000 | 9,378,000 | 10,150,000 | 3,182,000 |
| June | 2,425,000 | 3,019,000 | 8,704,000 | 8,445,000 | 2,556,000 |

| Month. | 1896-1897. | 1897-1898. | 1898-1899. | 1899-1900. | 1900-1901. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| July | 1,927,000 | 1,112,000 | 2,935,000 | 3,409,000 | 5,903,000 |
| August | 1,917,000 | 2,247,000 | 2,608,000 | 4,188,000 | 5,770,000 |
| September | 3,512,000 | 4,651,000 | 3,005,000 | 6,282,000 | 7,483,000 |
| October | 5,454,000 | 6,251,000 | 4,671,000 | 8,858,000 | 10,208,000 |
| November | 6,883,000 | 7,391,000 | 5,621,000 | 11,085,000 | 9,983,000 |
| December | 6,548,000 | 6,944,000 | 6,296,000 | 10,678,000 | 10,057,000 |
| January | 4,189,000 | 6,661,000 | 5,923,000 | 10,022,000 | 8,686,000 |
| February | 3,005,000 | 5,318,000 | 5,039,000 | 8,923,000 | 8,717,000 |
| March | 1,857,000 | 4,424,000 | 5,104,000 | 7,814,000 | 6,972,000 |
| April | 1,730,000 | 3,466,000 | 4,321,000 | 7,207,000 | 6,325,000 |
| May | 1,614,000 | 3,051,000 | 4,455,000 | 7,050,000 | ............ |
| June | 1,221,000 | 3,236,000 | 3,635,000 | 6,866,000 | ............ |

*Statement showing the amount of wheat in farmers' hands, visible supply of the United States and the world, and price, on March 1, 1891–1901.*

| Year. | Stocks in farmers' hands in United States on March 1. | Visible supply of the United States on March 1. | Visible supply of the world on March 1. | Price at Chicago March 1. |
|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Cts. per bu.* |
| 1891 | 112,000,000 | 42,401,815 | ........... | 94¼ |
| 1892 | 171,070,881 | 64,377,444 | 181,400,000 | 87⅜ |
| 1893 | 135,205,430 | 109,370,000 | 229,300,000 | 72⅝ |
| 1894 | 114,060,440 | 93,926,000 | 222,400,000 | 58⅜ |
| 1895 | 74,999,790 | 98,745,000 | 212,400,000 | 52¼ |
| 1896 | 123,045,290 | 94,538,000 | 191,900,000 | 66½ |
| 1897 | 88,149,072 | 61,624,000 | 155,500,000 | 74½ |
| 1898 | 121,320,500 | 46,532,000 | 140,500,000 | 104½ |
| 1899 | 198,056,496 | 51,085,000 | 151,100,000 | 72⅞ |
| 1900 | 158,700,000 | 85,570,000 | 181,500,000 | 64⅛ |
| 1901 | ........... | 80,704,000 | ........... | 74 |

*Condition of wheat crop in the United States, monthly, 1885–1900.*

| Year. | Winter wheat. | | | | | Spring wheat. | | | |
|---|---|---|---|---|---|---|---|---|---|
| | April. | May. | June. | July. | When harvested. | June. | July. | August. | When harvested. |
| 1885 | 76.3 | 70.0 | 62.0 | 65.0 | 66.0 | 97.0 | 96.0 | 95.0 | 86.0 |
| 1886 | 94.1 | 94.9 | 92.7 | 91.2 | 90.8 | 98.5 | 83.3 | 80.1 | 83.5 |
| 1887 | 88.1 | 85.8 | 84.9 | 83.5 | 84.0 | 87.3 | 79.3 | 78.8 | 78.1 |
| 1888 | 82.0 | 73.1 | 73.3 | 75.6 | 77.4 | 92.8 | 95.9 | 87.3 | 77.2 |
| 1889 | 94.0 | 96.0 | 93.1 | 92.0 | 89.4 | 94.4 | 83.3 | 81.2 | 83.8 |
| 1890 | 81.0 | 80.0 | 78.1 | 76.2 | 73.5 | 91.3 | 94.4 | 83.2 | 79.8 |
| 1891 | 96.9 | 97.9 | 96.6 | 96.2 | 96.7 | 92.6 | 94.1 | 95.5 | 97.2 |
| 1892 | 81.2 | 84.0 | 88.3 | 89.6 | 87.6 | 92.3 | 90.9 | 87.3 | 81.2 |
| 1893 | 77.4 | 75.3 | 75.5 | 77.7 | [1]74.0 | 86.4 | 74.1 | 67.0 | ........ |
| 1894 | 86.7 | 81.4 | 83.2 | 83.9 | [1]83.7 | 88.0 | 68.4 | 67.1 | ........ |
| 1895 | 81.4 | 82.9 | 71.1 | 65.8 | [1]75.4 | 97.8 | 102.2 | 95.9 | ........ |
| 1896 | 77.1 | 82.7 | 77.9 | 75.6 | [1]74.6 | 99.9 | 93.3 | 78.9 | ........ |
| 1897 | 81.4 | 80.2 | 78.5 | 81.2 | [1]85.7 | 89.6 | 91.2 | 86.7 | ........ |
| 1898 | 86.7 | 86.5 | 90.8 | 85.7 | [1]86.7 | 100.9 | 95.0 | 96.5 | ........ |
| 1899 | 77.9 | 76.2 | 67.3 | 65.6 | [1]70.9 | 91.4 | 91.7 | 83.6 | ........ |
| 1900 | 82.1 | 88.9 | 82.7 | 80.8 | [1]69.6 | 87.3 | 55.2 | 56.4 | ........ |

[1] Includes both winter and spring.

*Acreage, production, value, prices, and exports of wheat of the United States, 1866 to 1900, inclusive.*

| Year. | Acreage. | Average yield per acre. | Production. | Average farm price per bushel, Dec. 1. | Farm value, December 1. | Chicago cash price per bushel. | | | | Domestic exports, including flour, fiscal years beginning July 1. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | December. | | May of following year. | | |
| | | | | | | Low. | High. | Low. | High. | |
| | *Acres.* | *Bush.* | *Bushels.* | *Cents.* | *Dollars.* | *Cts.* | *Cts.* | *Cts.* | *Cts.* | *Bushels.* |
| 1866 | 15,424,496 | 9.9 | 151,999,906 | 152.7 | 232,109,630 | 129 | 145 | 185 | 211 | 12,646,941 |
| 1867 | 18,321,561 | 11.6 | 212,441,400 | 145.2 | 308,387,146 | 126 | 140 | 134 | 161 | 25,284,803 |
| 1868 | 18,460,132 | 12.1 | 224,036,600 | 108.5 | 243,032,746 | 80 | 88 | 87 | 96 | 29,717,201 |
| 1869 | 19,181,004 | 13.6 | 260,146,900 | 76.5 | 199,024,996 | 63 | 76 | 79 | 92 | 53,900,780 |
| 1870 | 18,992,591 | 12.4 | 235,884,700 | 94.4 | 222,766,969 | 91 | 98 | 113 | 120 | 52,580,111 |
| 1871 | 19,943,893 | 11.6 | 230,722,400 | 114.5 | 264,075,851 | 107 | 111 | 120 | 143 | 38,995,755 |
| 1872 | 20,858,359 | 11.9 | 249,997,100 | 111.4 | 278,522,068 | 97 | 108 | 112 | 122 | 52,014,715 |
| 1873 | 22,171,676 | 12.7 | 281,254,700 | 106.9 | 300,669,533 | 96 | 106 | 105 | 114 | 91,510,398 |
| 1874 | 24,967,027 | 12.3 | 308,102,700 | 86.3 | 265,881,167 | 78 | 83 | 78 | 94 | 72,912,817 |
| 1875 | 26,381,512 | 11.1 | 292,136,000 | 89.5 | 261,396,926 | 82 | 91 | 89 | 100 | 74,750,682 |
| 1876 | 27,627,021 | 10.5 | 289,356,500 | 96.3 | 278,697,238 | 104 | 117 | 130 | 172 | 57,043,936 |
| 1877 | 26,277,546 | 13.9 | 364,194,146 | 105.7 | 385,089,444 | 103 | 108 | 98 | 113 | 92,071,726 |
| 1878 | 32,108,560 | 13.1 | 420,122,400 | 77.6 | 325,814,119 | 81 | 84 | 91 | 102 | 150,502,506 |
| 1879 | 32,545,950 | 13.8 | 448,756,630 | 110.8 | 497,030,142 | 122 | 133½ | 112½ | 119 | 180,304,180 |
| 1880 | 37,986,717 | 13.1 | 498,549,868 | 95.1 | 474,201,850 | 93½ | 109¾ | 101 | 112⅝ | 186,321,514 |
| 1881 | 37,709,020 | 10.2 | 383,280,090 | 119.2 | 456,880,427 | 124¾ | 129 | 123 | 140 | 121,892,389 |
| 1882 | 37,067,194 | 13.6 | 504,185,470 | 88.4 | 445,602,125 | 91⅛ | 94¾ | 108 | 113⅜ | 147,811,316 |
| 1883 | 36,455,593 | 11.6 | 421,086,160 | 91.1 | 383,649,272 | 94⅝ | 99¼ | 85 | 94¾ | 111,534,182 |
| 1884 | 39,475,885 | 13.0 | 512,765,000 | 64.5 | 330,862,260 | 69½ | 76⅜ | 85⅜ | 90¾ | 132,570,366 |

*Acreage, production, value, prices, and exports of wheat in the United States, 1866 to 1900, inclusive*—Continued.

| Year. | Acreage. | Average yield per acre. | Production. | Average farm price per bushel, Dec. 1. | Farm value December 1. | Chicago cash price per bushel. December. Low. | Chicago cash price per bushel. December. High. | Chicago cash price per bushel. May of following year. Low. | Chicago cash price per bushel. May of following year. High. | Domestic exports, including flour, fiscal years beginning July 1. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Acres.* | *Bush.* | *Bushels.* | *Cents.* | *Dollars.* | *Cts.* | *Cts.* | *Cts.* | *Cts.* | *Bushels.* |
| 1885 | 34, 189, 246 | 10. 4 | 357, 112, 000 | 77. 1 | 275, 320, 390 | $82\frac{7}{8}$ | 89 | $72\frac{1}{8}$ | 79 | 94, 565, 793 |
| 1886 | 36, 806, 184 | 12. 4 | 457, 218, 000 | 68. 7 | 314, 226, 020 | $75\frac{1}{8}$ | $79\frac{1}{2}$ | $80\frac{3}{4}$ | $88\frac{3}{4}$ | 153, 804, 969 |
| 1887 | 37, 641, 783 | 12. 1 | 456, 329, 000 | 68. 1 | 310, 612, 960 | $75\frac{1}{8}$ | $79\frac{1}{4}$ | $81\frac{1}{4}$ | $89\frac{7}{8}$ | 119, 625, 344 |
| 1888 | 37, 336, 138 | 11. 1 | 415, 868, 000 | 92. 6 | 385, 248, 030 | $96\frac{5}{8}$ | $105\frac{1}{2}$ | $77\frac{1}{4}$ | $95\frac{1}{2}$ | 88, 600, 742 |
| 1889 | 38, 123, 859 | 12. 9 | 490, 560, 000 | 69. 8 | 342, 491, 707 | $76\frac{3}{4}$ | $80\frac{1}{2}$ | $89\frac{3}{4}$ | 100 | 109, 430, 467 |
| 1890 | 36, 087, 154 | 11. 1 | 399, 262, 000 | 83. 8 | 334, 773, 678 | $87\frac{1}{2}$ | $92\frac{3}{4}$ | $98\frac{7}{8}$ | 108 | 106, 181, 316 |
| 1891 | 39, 916, 897 | 15. 3 | 611, 780, 000 | 83. 9 | 513, 472, 711 | $89\frac{3}{8}$ | $93\frac{1}{4}$ | 80 | $85\frac{3}{4}$ | 225, 665, 812 |
| 1892 | 38, 554, 430 | 13. 4 | 515, 949, 000 | 62. 4 | 322, 111, 881 | $69\frac{1}{2}$ | 73 | $68\frac{1}{4}$ | $76\frac{1}{4}$ | 191, 912, 635 |
| 1893 | 34, 629, 418 | 11. 4 | 396, 131, 725 | 53. 8 | 213, 171, 381 | $59\frac{1}{8}$ | $64\frac{1}{2}$ | $52\frac{1}{8}$ | $60\frac{1}{2}$ | 164, 283, 129 |
| 1894 | 34, 882, 436 | 13. 2 | 460, 267, 416 | 49. 1 | 225, 902, 025 | $52\frac{3}{4}$ | $63\frac{5}{8}$ | $60\frac{3}{4}$ | $85\frac{3}{8}$ | 144, 812, 718 |
| 1895 | 34, 047, 332 | 13. 7 | 467, 102, 947 | 50. 9 | 237, 938, 998 | $53\frac{3}{4}$ | $64\frac{3}{4}$ | $57\frac{1}{8}$ | $67\frac{5}{8}$ | 126, 443, 968 |
| 1896 | 34, 618, 646 | 12. 4 | 427, 684, 346 | 72. 6 | 310, 602, 539 | $74\frac{5}{8}$ | $93\frac{1}{8}$ | $68\frac{3}{4}$ | $97\frac{7}{8}$ | 145, 124, 972 |
| 1897 | 39, 465, 066 | 13. 4 | 530, 149, 168 | 80. 8 | 428, 547, 121 | 92 | 109 | 117 | 185 | 217, 306, 005 |
| 1898 | 44, 055, 278 | 15. 3 | 675, 148, 705 | 58. 2 | 392, 770, 320 | $62\frac{3}{4}$ | 70 | $68\frac{3}{8}$ | $79\frac{1}{2}$ | 222, 618, 420 |
| 1899 | 44, 592, 516 | 12. 3 | 547, 303, 846 | 58. 4 | 319, 545, 259 | 64 | $69\frac{1}{2}$ | $63\frac{5}{8}$ | $67\frac{1}{2}$ | 186, 090, 564 |
| 1900 | 42, 495, 385 | 12. 3 | 522, 229, 505 | 61. 9 | 323, 515, 177 | $69\frac{1}{4}$ | $75\frac{5}{8}$ | ...... | ...... | ........... |

*Acreage, production, value, and distribution of wheat of the United States in 1900, by States.*

| States and Territories. | Crop of 1900. Acreage. | Crop of 1900. Production. | Crop of 1900. Value. | Stock on hand March 1, 1901. | | Shipped out of county where grown. |
|---|---|---|---|---|---|---|
| | *Acres.* | *Bushels.* | *Dollars.* | *Bushels.* | *Per cent.* | *Bushels.* |
| Maine | 2, 090 | 40, 755 | 36, 680 | 16, 710 | 41 | 0 |
| New Hampshire | 495 | 8, 085 | 7, 438 | 1, 860 | 23 | 0 |
| Vermont | 3, 489 | 81, 992 | 63, 954 | 30, 337 | 37 | 0 |
| Connecticut | 330 | 6, 864 | 5, 628 | 1, 922 | 28 | 0 |
| New York | 367, 015 | 6, 496, 166 | 5, 002, 048 | 2, 208, 696 | 34 | 909, 463 |
| New Jersey | 122, 753 | 2, 344, 582 | 1, 734, 991 | 468, 916 | 20 | 468, 916 |
| Pennsylvania | 1, 502, 321 | 20, 281, 334 | 14, 602, 560 | 6, 084, 400 | 30 | 6, 490, 027 |
| Delaware | 72, 864 | 1, 479, 139 | 1, 035, 397 | 325, 411 | 22 | 887, 483 |
| Maryland | 778, 864 | 15, 187, 848 | 10, 783, 372 | 2, 733, 813 | 18 | 9, 416, 466 |
| Virginia | 791, 759 | 9, 421, 932 | 6, 783, 791 | 2, 261, 264 | 24 | 3, 957, 211 |
| North Carolina | 620, 917 | 5, 960, 803 | 4, 887, 858 | 1, 788, 241 | 30 | 894, 120 |
| South Carolina | 238, 092 | 2, 142, 828 | 2, 164, 256 | 364, 281 | 17 | 107, 141 |
| Georgia | 550, 674 | 5, 011, 133 | 4, 760, 576 | 1, 302, 895 | 26 | 501, 113 |
| Alabama | 96, 458 | 916, 351 | 815, 552 | 164, 943 | 18 | 54, 981 |
| Mississippi | 4, 248 | 40, 781 | 34, 256 | 6, 117 | 15 | 408 |
| Texas | 1, 271, 517 | 23, 395, 913 | 14, 973, 384 | 4, 211, 264 | 18 | 9, 124, 406 |
| Arkansas | 266, 279 | 2, 689. 418 | 1, 748, 122 | 806, 825 | 30 | 537, 884 |
| Tennessee | 1, 181, 423 | 11, 696, 088 | 9, 239, 910 | 2, 573, 139 | 22 | 4, 444, 513 |
| West Virginia | 454, 377 | 4, 452, 895 | 3, 428, 729 | 1, 246, 811 | 28 | 1, 068, 695 |
| Kentucky | 957, 142 | 12, 442, 846 | 8, 585, 564 | 2, 737, 426 | 22 | 4, 977, 138 |
| Ohio | 1, 420, 646 | 8, 523, 876 | 6, 051, 952 | 1, 875, 253 | 22 | 1, 534, 298 |
| Michigan | 1, 219, 969 | 9, 271, 764 | 6, 397, 517 | 2, 688, 812 | 29 | 3, 152, 400 |
| Indiana | 1, 209, 755 | 6, 411, 702 | 4, 488, 191 | 1, 025, 872 | 16 | 1, 410, 574 |
| Illinois | 1, 383, 236 | 17, 982, 068 | 11, 508, 524 | 3, 236, 772 | 18 | 6, 833, 186 |
| Wisconsin | 849, 458 | 13, 166, 599 | 8, 426, 623 | 4, 476, 644 | 34 | 3, 949, 980 |
| Minnesota | 4, 905, 643 | 51, 509, 252 | 32, 450, 829 | 14, 937, 683 | 29 | 37, 086, 661 |
| Iowa | 1, 397, 322 | 21, 798, 223 | 12, 860, 952 | 6, 539, 467 | 30 | 10, 899, 111 |
| Missouri | 1, 507, 737 | 18, 846, 713 | 11, 873, 429 | 4, 523, 211 | 24 | 6, 784, 817 |
| Kansas | 4, 660, 376 | 82, 488, 655 | 45, 368, 760 | 20, 622, 164 | 25 | 61, 866, 491 |
| Nebraska | 2, 066, 825 | 24, 801, 900 | 13, 145, 007 | 7, 440, 570 | 30 | 12, 896, 988 |
| South Dakota | 2, 920, 244 | 20, 149, 684 | 11, 686, 817 | 5, 440, 415 | 27 | 13, 298, 791 |
| North Dakota | 2, 689, 023 | 13, 176, 213 | 7, 642, 204 | 3, 030, 529 | 23 | 7, 378, 679 |
| Montana | 72, 555 | 1, 929, 963 | 1, 177, 277 | 463, 191 | 24 | 578, 989 |
| Wyoming | 20, 819 | 366, 414 | 278, 475 | 76, 947 | 21 | 18, 321 |
| Colorado | 318, 899 | 7, 207, 117 | 4, 252, 199 | 1, 801, 779 | 25 | 4, 828, 768 |
| New Mexico | 183, 207 | 3, 847, 347 | 2, 616, 196 | 1, 192, 678 | 31 | 307, 788 |
| Arizona | 25, 045 | 365, 657 | 288, 869 | 43, 879 | 12 | 76, 788 |
| Utah | 176, 895 | 3, 697, 106 | 2, 033, 408 | 1, 293, 987 | 35 | 1, 626, 727 |
| Nevada | 40, 457 | 991, 196 | 693, 837 | 218, 063 | 22 | 178, 415 |
| Idaho | 149, 261 | 3, 104, 629 | 1, 428, 129 | 1, 148, 713 | 37 | 1, 769, 639 |
| Washington | 1, 067, 943 | 25, 096, 661 | 12, 799, 297 | 5, 521, 265 | 22 | 20, 077, 329 |
| Oregon | 1, 173, 769 | 16, 198, 012 | 8, 908, 907 | 3, 239, 602 | 20 | 7, 937, 026 |
| California | 2, 771, 226 | 28, 543, 628 | 16, 555, 304 | 4, 566, 980 | 16 | 19, 980, 540 |
| Oklahoma | 981, 967 | 18, 657, 373 | 9, 888, 408 | 3, 358, 327 | 18 | 13, 060, 161 |
| United States | 42, 495, 385 | 522, 229, 505 | 323, 515, 177 | 128, 098, 074 | 24. 5 | 281, 372, 432 |

*Average yield per acre of wheat in the United States, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* |
| Maine | 16.3 | 16.7 | 16.0 | 21.1 | 19.2 | 22.0 | 16.5 | 19.5 | 22.5 | 19.5 |
| New Hampshire | 16.5 | 16.2 | 15.0 | 20.0 | 19.3 | 21.0 | 16.0 | 19.0 | 17.2 | 16.3 |
| Vermont | 17.5 | 17.3 | 16.8 | 22.7 | 29.0 | 24.5 | 17.0 | 22.5 | 22.0 | 23.5 |
| Connecticut | 17.0 | 16.7 | 18.3 | ...... | ...... | ...... | 20.0 | 20.0 | 18.3 | 20.8 |
| New York | 16.6 | 16.2 | 14.5 | 14.8 | 18.1 | 16.0 | 21.4 | 21.2 | 18.5 | 17.7 |
| New Jersey | 15.3 | 14.3 | 14.5 | 15.3 | 12.4 | 15.3 | 18.5 | 17.4 | 14.5 | 19.1 |
| Pennsylvania | 15.6 | 14.6 | 14.0 | 15.0 | 16.6 | 14.0 | 19.7 | 17.5 | 13.6 | 13.5 |
| Delaware | 12.8 | 13.0 | 14.7 | 13.0 | 11.6 | 18.0 | 21.5 | 13.3 | 12.8 | 20.3 |
| Maryland | 15.0 | 13.2 | 13.5 | 15.3 | 17.0 | 17.0 | 19.2 | 15.3 | 14.1 | 19.5 |
| Virginia | 9.0 | 9.5 | 11.2 | 9.5 | 9.3 | 9.3 | 12.0 | 14.1 | 8.4 | 11.9 |
| North Carolina | 6.8 | 7.1 | 8.2 | 5.0 | 6.9 | 7.3 | 8.0 | 9.2 | 6.7 | 9.6 |
| South Carolina | 5.5 | 6.5 | 6.3 | 5.6 | 6.4 | 6.8 | 8.7 | 10.6 | 6.5 | 9.0 |
| Georgia | 7.5 | 6.8 | 7.2 | 6.9 | 6.2 | 8.0 | 9.4 | 10.0 | 6.8 | 9.1 |
| Alabama | 8.0 | 6.7 | 8.2 | 8.3 | 7.5 | 8.0 | 10.0 | 12.0 | 7.6 | 9.5 |
| Mississippi | 7.8 | 6.8 | 7.5 | 9.8 | 8.0 | 8.5 | 10.0 | 13.9 | 7.7 | 9.6 |
| Texas | 12.0 | 12.3 | 10.5 | 15.1 | 5.7 | 11.7 | 15.8 | 14.8 | 11.1 | 18.4 |
| Arkansas | 9.6 | 8.2 | 8.0 | 8.8 | 9.4 | 8.0 | 10.5 | 11.0 | 8.6 | 10.1 |
| Tennessee | 9.7 | 9.5 | 9.2 | 8.1 | 8.8 | 8.5 | 11.2 | 13.2 | 8.7 | 9.9 |
| West Virginia | 10.3 | 10.7 | 11.5 | 12.1 | 10.6 | 10.3 | 13.4 | 13.8 | 9.3 | 9.8 |
| Kentucky | 12.7 | 11.8 | 11.3 | 12.5 | 10.9 | 8.7 | 13.6 | 15.4 | 9.1 | 13.0 |
| Ohio | 17.1 | 13.6 | 14.5 | 19.0 | 13.3 | 9.0 | 16.9 | 16.9 | 14.2 | 6.0 |
| Michigan | 18.8 | 14.7 | 13.2 | 15.8 | 13.2 | 12.8 | 15.6 | 20.8 | 8.4 | 7.6 |
| Indiana | 18.1 | 14.7 | 14.1 | 18.4 | 9.2 | 9.0 | 13.0 | 15.6 | 9.8 | 5.3 |
| Illinois | 18.0 | 16.2 | 11.5 | 18.2 | 11.0 | 14.7 | 7.9 | 11.0 | 10.0 | 13.0 |
| Wisconsin | 13.5 | 11.5 | 13.3 | 16.5 | 15.5 | 13.3 | 12.5 | 18.0 | 15.5 | 15.5 |
| Minnesota | 17.6 | 11.6 | 9.6 | 13.5 | 23.0 | 14.2 | 13.0 | 15.8 | 13.4 | 10.5 |
| Iowa | 15.3 | 11.5 | 11.5 | 14.8 | 19.5 | 16.0 | 13.0 | 16.7 | 13.0 | 15.6 |
| Missouri | 13.6 | 12.5 | 9.5 | 15.3 | 12.0 | 11.7 | 9.0 | 9.8 | 9.9 | 12.5 |
| Kansas | 15.5 | 17.4 | 8.4 | 10.4 | 7.7 | 10.6 | 15.5 | 14.2 | 9.8 | 17.7 |
| Nebraska | 15.0 | 12.5 | 8.7 | 7.0 | 12.0 | 14.0 | 14.5 | 16.4 | 10.3 | 12.0 |
| South Dakota | 15.2 | 12.5 | 8.5 | 6.6 | 12.0 | 11.2 | 8.0 | 12.4 | 10.7 | 6.9 |
| North Dakota | 17.8 | 12.2 | 9.6 | 11.8 | 21.0 | 11.8 | 10.3 | 14.4 | 12.8 | 4.9 |
| Montana | 20.0 | 21.5 | 21.5 | 24.8 | 23.9 | 26.5 | 32.5 | 29.5 | 25.7 | 26.6 |
| Wyoming | 20.0 | 17.5 | 18.7 | 19.6 | 26.0 | 24.5 | 25.0 | 23.7 | 18.8 | 17.6 |
| Colorado | 20.2 | 19.1 | 13.2 | 17.9 | 23.5 | 17.5 | 24.0 | 26.3 | 23.7 | 22.6 |
| New Mexico | 11.5 | 13.8 | 16.8 | 18.0 | 20.4 | 21.0 | 24.0 | 23.8 | 13.8 | 21.0 |
| Arizona | 14.5 | 15.6 | 17.5 | 17.0 | 20.5 | 23.0 | 18.0 | 31.7 | 15.3 | 14.6 |
| Utah | 17.5 | 17.3 | 13.8 | 22.0 | 22.4 | 26.5 | 21.0 | 28.0 | 20.7 | 20.9 |
| Nevada | 18.3 | 19.2 | 14.7 | 20.0 | 21.7 | 30.0 | 24.3 | 29.0 | 18.0 | 24.5 |
| Idaho | 20.0 | 22.0 | 19.3 | 20.6 | 17.8 | 24.5 | 22.0 | 31.0 | 24.2 | 20.8 |
| Washington | 17.5 | 17.2 | 20.3 | 16.6 | 15.5 | 18.0 | 23.5 | 24.2 | 22.7 | 23.5 |
| Oregon | 19.0 | 15.7 | 17.5 | 17.7 | 20.0 | 17.0 | 17.0 | 20.5 | 19.2 | 13.8 |
| California | 13.0 | 13.0 | 13.3 | 11.3 | 13.0 | 14.6 | 10.0 | 9.1 | 14.1 | 10.3 |
| Oklahoma | ...... | ...... | ...... | 11.3 | 11.4 | 13.0 | 19.0 | 14.9 | 13.3 | 19.0 |
| General average | 15.33 | 13.38 | 11.44 | 13.19 | 13.72 | 12.35 | 13.43 | 15.33 | 12.27 | 12.29 |

*Average yield of wheat in certain countries, in bushels, per acre, 1894–1899.*

| Year. | United States. | Russia. | Germany. | Austria. | Hungary. | France. | United Kingdom. |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (2) | (1) | (1) | (1) | (1) |
| 1894 | 13.2 | 10.8 | 25.1 | 17.7 | 17.8 | 20.1 | 31.7 |
| 1895 | 13.7 | 9.8 | 24.4 | 15.8 | 26.1 | 19.7 | 27.2 |
| 1896 | 12.4 | 9.0 | 26.4 | 16.8 | 19.2 | 20.0 | 34.7 |
| 1897 | 13.4 | 7.3 | 25.3 | 13.7 | 12.1 | 15.1 | 30.0 |
| 1898 | 15.3 | 9.8 | 27.2 | 18.1 | 17.1 | 21.1 | 35.8 |
| 1899 | 12.3 | 9.1 | 28.4 | 19.4 | 17.9 | 21.2 | 33.8 |
| Average | 13.4 | 9.3 | 26.1 | 16.9 | 17.4 | 19.5 | 32.2 |

1 Winchester bushels.

2 Bushels of 60 pounds.

## Storage of Grain in Bulk.

The storage of grain in large bulk is commended, as the surface layers only are exposed to insect infestation. This practice is practicularly valuable against the moths, which do not penetrate far beneath the surface. Frequent agitation of the grain is also destructive to the moths. The rice and granary weevils, however, penetrate more deeply, and, although bulking is of value against them, it is not advisable to stir the grain, as it merely distributes them more thoroughly through the mass.

*Average value per acre of wheat in the United States, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| Maine | $17.93 | $17.03 | $16.32 | $16.67 | $15.74 | $18.48 | $17.49 | $17.36 | $20.47 | $17.55 |
| New Hampshire | 18.98 | 16.30 | 12.75 | 16.00 | 14.67 | 21.00 | 17.60 | 17.48 | 16.34 | 15.00 |
| Vermont | 19.95 | 16.51 | 14.28 | 15.21 | 20.01 | 22.79 | 17.68 | 20.25 | 18.70 | 18.33 |
| Connecticut | 17.85 | 14.53 | ...... | ...... | ...... | ...... | 20.00 | 17.60 | 17.39 | 17.05 |
| New York | 16.60 | 13.77 | 11.02 | 9.18 | 12.31 | 14.08 | 19.26 | 15.26 | 14.80 | 13.63 |
| New Jersey | 15.91 | 11.87 | 10.15 | 9.33 | 8.80 | 13.62 | 17.20 | 12.70 | 10.88 | 14.13 |
| Pennsylvania | 15.60 | 11.83 | 9.10 | 8.40 | 10.79 | 11.62 | 17.93 | 11.90 | 8.98 | 9.72 |
| Delaware | 12.80 | 9.75 | 8.82 | 7.15 | 7.42 | 15.66 | 20.21 | 9.18 | 8.70 | 14.21 |
| Maryland | 15.00 | 9.77 | 10.26 | 8.26 | 10.88 | 14.96 | 17.86 | 10.71 | 9.59 | 13.84 |
| Virginia | 9.00 | 7.22 | 7.06 | 5.32 | 6.05 | 7.44 | 11.04 | 9.31 | 5.80 | 8.57 |
| North Carolina | 6.94 | 6.32 | 5.90 | 3.25 | 4.97 | 6.06 | 7.52 | 7.18 | 5.49 | 7.87 |
| South Carolina | 6.05 | 6.04 | 6.17 | 4.87 | 5.63 | 6.05 | 10.27 | 9.96 | 6.44 | 9.09 |
| Georgia | 8.25 | 6.12 | 6.48 | 5.24 | 5.08 | 7.12 | 9.68 | 9.80 | 6.66 | 8.64 |
| Alabama | 8.80 | 6.23 | 7.22 | 6.47 | 6.00 | 6.80 | 10.10 | 10.80 | 6.76 | 8.45 |
| Mississippi | 7.80 | 6.12 | 6.55 | 7.35 | 4.88 | 6.97 | 9.90 | 11.54 | 6.01 | 8.06 |
| Texas | 10.44 | 9.23 | 6.09 | 8.15 | 3.76 | 8.78 | 14.06 | 10.06 | 7.55 | 11.78 |
| Arkansas | 8.64 | 6.56 | 5.20 | 4.84 | 5.55 | 5.68 | 8.82 | 6.38 | 5.50 | 6.57 |
| Tennessee | 9.02 | 6.46 | 5.24 | 4.13 | 5.46 | 6.29 | 10.64 | 8.84 | 6.79 | 7.82 |
| West Virginia | 9.89 | 8.03 | 8.28 | 7.26 | 7.31 | 8.03 | 11.93 | 9.80 | 6.60 | 7.55 |
| Kentucky | 11.43 | 7.91 | 6.44 | 6.25 | 6.65 | 6.61 | 12.10 | 9.55 | 6.01 | 8.97 |
| Ohio | 15.73 | 9.25 | 8.27 | 9.31 | 7.98 | 7.02 | 14.87 | 11.15 | 9.09 | 4.26 |
| Michigan | 17.11 | 9.85 | 7.52 | 8.22 | 7.92 | 10.75 | 13.57 | 13.31 | 5.46 | 5.24 |
| Indiana | 15.57 | 9.41 | 7.47 | 8.46 | 5.24 | 7.20 | 11.57 | 9.83 | 6.27 | 3.71 |
| Illinois | 15.30 | 10.21 | 5.87 | 8.19 | 5.83 | 10.88 | 7.03 | 6.60 | 6.30 | 8.32 |
| Wisconsin | 11.34 | 7.13 | 7.18 | 8.42 | 7.91 | 9.31 | 10.50 | 10.62 | 9.46 | 9.92 |
| Minnesota | 13.73 | 7.08 | 4.90 | 6.62 | 10.12 | 9.66 | 10.01 | 8.53 | 7.37 | 6.62 |
| Iowa | 12.39 | 6.90 | 5.64 | 7.40 | 8.97 | 9.92 | 9.75 | 8.68 | 7.15 | 9.20 |
| Missouri | 10.88 | 7.25 | 4.56 | 6.58 | 6.12 | 8.19 | 7.65 | 5.78 | 6.14 | 7.88 |
| Kansas | 11.31 | 9.05 | 3.53 | 4.58 | 3.47 | 6.68 | 11.47 | 7.10 | 5.10 | 9.73 |
| Nebraska | 10.95 | 6.25 | 3.48 | 3.43 | 4.80 | 8.12 | 10.00 | 7.71 | 5.05 | 6.36 |
| South Dakota | 10.94 | 6.38 | 3.74 | 3.04 | 4.56 | 6.94 | 5.52 | 6.20 | 5.35 | 4.00 |
| North Dakota | 12.46 | 6.34 | 4.13 | 5.07 | 7.98 | 7.55 | 7.62 | 7.34 | 6.53 | 2.84 |
| Montana | 16.80 | 14.84 | 12.90 | 13.39 | 17.45 | 17.49 | 22.10 | 17.11 | 15.68 | 16.23 |
| Wyoming | 16.40 | 11.55 | 12.15 | 12.35 | 16.64 | 15.19 | 17.50 | 16.35 | 12.60 | 13.38 |
| Colorado | 14.75 | 11.08 | 6.86 | 11.64 | 13.16 | 10.67 | 16.80 | 14.73 | 13.51 | 13.33 |
| New Mexico | 9.43 | 11.04 | 12.60 | 15.84 | 14.89 | 13.86 | 18.00 | 14.76 | 8.42 | 14.28 |
| Arizona | 10.88 | 12.17 | 11.38 | 17.00 | 13.33 | 18.40 | 13.32 | 29.16 | 9.79 | 11.53 |
| Utah | 13.13 | 10.73 | 8.28 | 11.66 | 9.86 | 18.02 | 14.28 | 15.12 | 10.97 | 11.49 |
| Nevada | 15.92 | 14.40 | 10.73 | 15.00 | 10.63 | 20.70 | 21.87 | 27.55 | 13.68 | 17.15 |
| Idaho | 16.80 | 13.20 | 11.58 | 9.48 | 8.37 | 15.93 | 15.40 | 15.81 | 12.10 | 9.57 |
| Washington | 13.12 | 9.98 | 9.74 | 6.47 | 6.35 | 13.32 | 15.98 | 13.07 | 11.58 | 11.99 |
| Oregon | 16.72 | 10.05 | 9.63 | 7.61 | 9.40 | 12.24 | 12.24 | 12.71 | 10.18 | 7.59 |
| California | 12.35 | 8.84 | 7.05 | 6.44 | 7.80 | 12.12 | 8.30 | 6.55 | 8.74 | 5.97 |
| Oklahoma | ...... | ...... | ...... | 5.76 | 5.47 | 8.84 | 14.44 | 7.75 | 7.05 | 10.07 |
| General average | 12.86 | 8.35 | 6.16 | 6.48 | 6.99 | 8.97 | 10.86 | 8.92 | 7.17 | 7.61 |

## Protection of Stored Grain from Insects.

The bisulphide of carbon is probably the best known remedy against all insects that infest stored grain, but the following measures, principally preventive, may be profitably employed:

Prompt thrashing to prevent the Angoumois grain moth, rice weevil, and some other species in the extreme South from obtaining access to the granary.

Inspection, quarantining, and disinfection of infested or suspected grain, bags, and machinery before permanent storage.

Scrupulous cleanliness, including the prompt destruction of refuse material, which will accomplish much in lessening the chances of injury.

Constructing or refitting the warehouse or mill, especially in warm latitudes, with a view to the exclusion of insects.

Substitution of metal for wooden spouts, etc., and the use of other improved machinery in mills infested with the flour moth.

Storage in large bulk, particularly valuable against grain moths.

Storage in a cool, dry repository, well ventilated to prevent "heating."

The use of naphthaline as a preservative of small samples in tight receptacles.

*Average farm price of wheat per bushel in the United States December 1, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| Maine | $1.10 | $1.02 | $1.02 | $0.79 | $0.82 | $0.84 | $1.06 | $0.89 | $0.91 | $0.90 |
| New Hampshire | 1.15 | 1.00 | .85 | .80 | .76 | 1.00 | 1.10 | .92 | .95 | .92 |
| Vermont | 1.14 | .96 | .85 | .67 | .69 | .93 | 1.04 | .90 | .85 | .78 |
| New York | 1.06 | .87 | ...... | ...... | .68 | ...... | 1.00 | .88 | .95 | .82 |
| Connecticut | 1.00 | .85 | .76 | .62 | .68 | .88 | .90 | .72 | .80 | .77 |
| New Jersey | 1.04 | .83 | .70 | .61 | .71 | .89 | .93 | .73 | .75 | .74 |
| Pennsylvania | 1.00 | .81 | .65 | .56 | .65 | .83 | .91 | .68 | .66 | .72 |
| Delaware | 1.00 | .75 | .60 | .55 | .64 | .87 | .94 | .69 | .68 | .70 |
| Maryland | 1.00 | .74 | .76 | .54 | .64 | .88 | .93 | .70 | .68 | .71 |
| Virginia | 1.00 | .76 | .63 | .56 | .65 | .80 | .92 | .66 | .69 | .72 |
| North Carolina | 1.02 | .89 | .72 | .65 | .72 | .83 | .94 | .78 | .82 | .82 |
| South Carolina | 1.10 | .93 | .98 | .87 | .88 | .89 | 1.18 | .94 | .99 | 1.01 |
| Georgia | 1.10 | .90 | .90 | .76 | .82 | .89 | 1.03 | .98 | .98 | .95 |
| Alabama | 1.10 | .93 | .88 | .78 | .80 | .85 | 1.01 | .90 | .89 | .89 |
| Mississippi | 1.00 | .90 | .85 | .75 | .61 | .82 | .99 | .83 | .78 | .84 |
| Texas | .87 | .75 | .58 | .54 | .66 | .75 | .89 | .68 | .68 | .64 |
| Arkansas | .90 | .80 | .65 | .55 | .59 | .71 | .84 | .58 | .64 | .65 |
| Tennessee | .93 | .68 | .57 | .51 | .62 | .74 | .95 | .67 | .78 | .79 |
| West Virginia | .96 | .75 | .72 | .60 | .69 | .78 | .89 | .71 | .71 | .77 |
| Kentucky | .90 | .67 | .57 | .50 | .61 | .76 | .89 | .62 | .66 | .69 |
| Ohio | .92 | .68 | .57 | .49 | .60 | .78 | .88 | .66 | .64 | .71 |
| Michigan | .91 | .67 | .57 | .52 | .60 | .84 | .87 | .64 | .65 | .69 |
| Indiana | .86 | .64 | .53 | .46 | .57 | .80 | .89 | .63 | .64 | .70 |
| Illinois | .85 | .63 | .51 | .45 | .53 | .74 | .89 | .60 | .63 | .64 |
| Wisconsin | .84 | .62 | .54 | .51 | .51 | .70 | .84 | .59 | .61 | .64 |
| Minnesota | .78 | .61 | .51 | .49 | .44 | .68 | .77 | .54 | .55 | .63 |
| Iowa | .81 | .60 | .49 | .50 | .46 | .62 | .75 | .52 | .55 | .59 |
| Missouri | .80 | .58 | .48 | .43 | .51 | .70 | .85 | .59 | .62 | .63 |
| Kansas | .73 | .52 | .42 | .44 | .45 | .63 | .74 | .50 | .52 | .55 |
| Nebraska | .73 | .50 | .40 | .49 | .40 | .58 | .69 | .47 | .49 | .53 |
| South Dakota | .72 | .51 | .44 | .46 | .38 | .62 | .69 | .50 | .50 | .58 |
| North Dakota | .70 | .52 | .43 | .43 | .38 | .64 | .74 | .51 | .51 | .58 |
| Montana | .84 | .69 | .60 | .54 | .73 | .66 | .68 | .58 | .61 | .61 |
| Wyoming | .82 | .66 | .65 | .63 | .64 | .62 | .70 | .69 | .67 | .76 |
| Colorado | .73 | .58 | .52 | .65 | .56 | .61 | .70 | .56 | .57 | .59 |
| New Mexico | .82 | .80 | .75 | .88 | .73 | .66 | .75 | .62 | .61 | .68 |
| Arizona | .75 | .78 | .65 | 1.00 | .65 | .80 | .74 | .92 | .64 | .79 |
| Utah | .75 | .62 | .60 | .53 | .44 | .68 | .68 | .54 | .53 | .55 |
| Nevada | .87 | .75 | .73 | .75 | .49 | .69 | .90 | .95 | .76 | .70 |
| Idaho | .84 | .60 | .60 | .46 | .47 | .65 | .70 | .51 | .50 | .46 |
| Washington | .75 | .58 | .48 | .39 | .41 | .74 | .68 | .54 | .51 | .51 |
| Oregon | .88 | .64 | .55 | .43 | .47 | .72 | .72 | .62 | .53 | .55 |
| California | .95 | .68 | .53 | .57 | .60 | .83 | .83 | .72 | .62 | .58 |
| Oklahoma | ...... | ...... | ...... | .51 | .48 | .68 | .76 | .52 | .53 | .53 |
| General average | .839 | .624 | .538 | .491 | .509 | .726 | .808 | .582 | .584 | .619 |

## Use of Bisulphide of Carbon against Insects.

The simplest, most effective, and inexpensive remedy for all insects that affect stored cereal and other products is the bisulphide of carbon. It vaporizes abundantly at ordinary temperatures, is highly inflammable, and is a powerful poison.

It may be applied directly to infested grain or seed without injury to the edible or germinative principles by spraying or pouring, but the most effective manner of its application in moderately tight bins or other receptacles consists in evaporating the liquid in shallow dishes or pans, or on bits of cloth or cotton waste distributed about on the surface of the infested material. The liquid rapidly volatilizes, and being heavier than air descends and permeates the mass of grain, killing all insects and other vermin present.

The bisulphide is usually evaporated in vessels containing one-fourth or one-half of a pound each, and is applied in tight bins at the rate of a pound to a pound and a half to the ton of grain, and in more open bins a larger quantity is used. For smaller masses of grain or other material an ounce is evaporated to every 100 pounds of the infested matter. Bins may be rendered nearly air-tight by covering with cloths, blankets, or canvas.

Infested grain is generally subjected to the bisulphide treatment for twenty-four hours, but may be exposed much longer without harming it for milling purposes. If not exposed for more than thirty-six hours its germinating power will not be impaired.

No fire, not even a lighted cigar, should be brought near until the fumes of the bisulphide have entirely passed away, and the vapor should not be breathed heedlessly, though a small amount is not dangerous.

*Wholesale prices of wheat per bushel in leading cities of the United States, 1896–1900.*

| Date. | New York. | | Baltimore. | | Chicago. | | Detroit. | | St. Louis. | | Minneapolis. | | San Francisco. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. 2, red winter. | | Southern, No. 2, red. | | | | No. 2, red. | | No. 2, red winter. | | No. 2, northern. | | No. 1, California (per cwt.). | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | | | | | | | | | | | | | | |
| January | $0.68½ | $0.78¾ | $0.66 | $0.76 | $0.55¾ | $0.68⅞ | $0.65½ | $0.72¾ | $0.63 | $0.72 | $0.53½ | $0.58 | $1.01¼ | $1.12½ |
| February | .78⅞ | .82⅝ | .74 | .78 | .62 | .71¼ | .72½ | .75¾ | .71 | .74½ | .59 | .61½ | 1.12½ | 1.13¾ |
| March | .76¾ | .82⅝ | .74 | .78 | .59⅞ | .71 | .68 | .74¾ | .67¾ | .72½ | .57¼ | .61¼ | 1.07½ | 1.12½ |
| April | .73⅝ | .83⅜ | .73 | .78 | .61¼ | .71 | .67¼ | .75½ | .65½ | .72¾ | .58¾ | .62⅝ | 1.07½ | 1.07½ |
| May | .71⅜ | .75¾ | .66 | .74 | .57⅛ | .67⅝ | .65 | .69 | .55¾ | .68¼ | .55⅞ | .60½ | 1.05 | 1.07½ |
| June | .63¾ | .76⅛ | .51 | .68 | .53⅝ | .67 | .58 | .67½ | .52½ | .60 | .51⅝ | .58½ | .96¼ | 1.02½ |
| July | .62 | .67½ | .53 | .64½ | .54¼ | .62¼ | .57½ | .64¾ | .52½ | .58¾ | .52⅛ | .55⅜ | .92½ | .95 |
| August | .64¾ | .68⅝ | .57 | .65½ | .53 | .63⅛ | .61½ | .64⅞ | .58 | .64 | .50 | .54¾ | .93¾ | .96¼ |
| September | .65 | .77⅝ | .59 | .71¾ | .55 | .70 | .59⅝ | .71 | .56¼ | .58¼ | .51 | .64 | .96¼ | 1.06¼ |
| October | .77⅛ | .90½ | .69 | .84 | .65½ | .81¼ | .70½ | .84½ | .68 | .80½ | .63½ | .75 | 1.15 | 1.33¾ |
| November | .85¾ | 1.02⅝ | .76 | .96 | .71 | .94⅜ | .80½ | .97 | .76 | .91 | .73 | .81½ | 1.48¾ | 1.50 |
| December | .99⅞ | 1.06⅞ | .88 | .96 | .74⅝ | .93⅛ | .90 | .96¾ | .89 | .92⅜ | .74½ | .80⅝ | 1.47½ | 1.50 |
| **1897.** | | | | | | | | | | | | | | |
| January | .91¾ | 1.01⅜ | .87 | .97 | .71¼ | .94 | .85 | .94¾ | .80 | .92½ | .71⅝ | .79⅜ | 1.50 | 1.56¼ |
| February | .88¼ | .96¾ | .87 | .92 | .71⅜ | .87⅞ | .85 | .89 | .80⅞ | .89⅛ | .71⅛ | .73⅝ | 1.32½ | 1.40 |
| March | .81⅝ | .89⅛ | .83 | .92 | .69⅜ | .90¼ | .85 | .91½ | .90⅞ | .95½ | .69⅝ | .74½ | 1.28¾ | 1.36¼ |
| April | ........ | ........ | .73 | .85 | .64⅛ | .97 | .83½ | .93¾ | .90 | 1.03 | .65¼ | .77⅝ | 1.21¼ | 1.30 |
| May | ........ | ........ | .80 | .90 | .68¾ | .97⅞ | .79½ | .92½ | .82½ | .97 | .69¼ | .75 | 1.30 | 1.32½ |
| June | ........ | ........ | .55 | .81 | .66⅞ | .83½ | .76 | .83 | .74 | .84½ | .68½ | .71⅞ | 1.22½ | 1.23¾ |
| July | ........ | ........ | .50 | .85 | .68¼ | .79¾ | .74½ | .79¼ | .65½ | .79 | .69¾ | .79¾ | 1.21¼ | 1.40 |
| August | .86⅜ | 1.11¼ | .80 | 1.07½ | .75¼ | 1.07 | .77½ | 1.01 | .79 | 1.03 | .79¾ | 1.07½ | 1.46¼ | 1.55 |
| September | .94⅛ | 1.07½ | .89 | 1.04¼ | .85½ | 1.01¼ | .91½ | 1.00 | .93¼ | 1.01 | .85 | .96¼ | 1.47½ | 1.56¼ |
| October | .94⅜ | 1.05 | .88 | 1.01 | .87⅞ | .99¼ | .91 | .97½ | .93½ | 1.01 | .85 | .92½ | 1.45 | 1.47½ |
| November | .97¾ | 1.03½ | .90 | 1.01 | .91 | 1.00½ | .91 | .97 | .94¾ | .99¾ | .87¼ | .92½ | 1.40 | 1.48¾ |
| December | .97 | 1.03¼ | .91 | 1.00 | .92 | 1.09 | .89¼ | .94½ | .95½ | 1.02 | .86⅝ | .93¼ | 1.40 | 1.42½ |
| **1898.** | | | | | | | | | | | | | | |
| January | .99¾ | 1.10½ | .90 | 1.01½ | .89⅛ | 1.10 | .90 | .97¾ | .92½ | 1.00½ | .87½ | .96 | 1.37½ | 1.41¼ |
| February | 1.02¼ | 1.10¼ | .93 | 1.04 | .95 | 1.08 | .93½ | .99¼ | .94¾ | 1.01 | .92¾ | 1.00 | 1.41¼ | 1.42½ |
| March | .99⅞ | 1.08⅞ | .94 | 1.03 | 1.00 | 1.06¾ | .94¼ | .98½ | .96 | 1.00 | .94½ | .99½ | 1.40 | 1.46¼ |
| April | 1.01 | 1.28 | .95 | 1.15 | 1.01 | 1.23½ | .94½ | 1.12½ | .97 | 1.10 | .95¼ | 1.16¾ | 1.48¾ | 1.80 |
| May | 1.16½ | 1.93½ | 1.10 | 1.46½ | 1.17 | 1.85 | 1.10 | 1.60 | 1.00 | 1.27 | 1.14½ | 1.55 | 1.60 | 1.77½ |
| June | .82 | 1.21 | .60 | 1.16½ | .75 | 1.20 | .82 | 1.12 | .69 | 1.00½ | .80 | 1.30 | 1.60 | 1.77½ |
| July | .74½ | .94 | .62 | .87 | .65¾ | .88 | .66½ | .90 | .64½ | .79 | .80 | .87½ | 1.22½ | 1.25 |
| August | .73⅛ | .81¾ | .60 | .81 | .65½ | .75 | .67 | .74 | .64 | .73 | .70 | .87 | 1.08¾ | 1.20 |
| September | .68¾ | .79⅞ | .60 | .73¼ | .62¾ | .68 | .67 | .70 | .65 | .70 | .55 | .63 | 1.10 | 1.18¾ |
| October | .72 | .80¼ | .63 | .77½ | .62 | .70¼ | .65½ | .74 | .65¾ | .72¾ | .56 | .67 | 1.15 | 1.22½ |
| November | .74¾ | .78¾ | .65 | .74 | .64½ | .69½ | .69 | .71¾ | .67½ | .71⅞ | .60 | .63 | 1.15 | 1.21¼ |
| December | .73⅞ | .81¼ | .62 | .77 | .62¾ | .70 | .66¾ | .72¼ | .68⅛ | .73 | .60 | .67 | 1.13¾ | 1.15 |

*Wholesale prices of wheat per bushel in leading cities of the United States, 1896–1900*—Continued.

| Date. | New York. | | Baltimore. | | Chigago. | | Detroit. | | St. Louis. | | Minneapolis. | | San Francisco. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. 2, red winter. | | Southern, No. 2, red. | | | | No. 2, red. | | No. 2, red winter. | | No. 2, northern. | | No. 1, California (per cwt.). | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High |
| **1899.** | | | | | | | | | | | | | | |
| January | $0.79¼ | $0.87⅜ | $0.76 | $0.81½ | $0.66½ | $0.76 | $0.70½ | $0.76½ | $0.71 | $0.79½ | $0.65½ | $0.72¼ | $1.12½ | $1.18¾ |
| February | .81 | .87⅜ | .74½ | .78 | .69¾ | .74½ | .72¼ | .74½ | .72½ | .76 | .67⅜ | .69¼ | 1.10 | 1.13¾ |
| March | .78⅝ | .87½ | .72 | .78 | .66 | .74½ | .69 | .75 | .69 | .76 | .64 | .70¼ | 1.06¼ | 1.15 |
| April | .79⅜ | .85¼ | .75½ | .79½ | .70 | .76½ | .71½ | .76¾ | .73⅝ | .80 | .68 | .72 | 1.05 | 1.10 |
| May | .80⅛ | .87⅛ | .73¼ | .79½ | .68⅜ | .79½ | .73¼ | .80 | .73¼ | .81⅝ | .67¼ | .73 | 1.06¼ | 1.12½ |
| June | .80 | .85⅞ | .75 | .79 | .71¼ | .79¼ | .75¼ | .80¼ | .73¾ | .78½ | .70½ | .73⅞ | 1.10 | 1.12½ |
| July | .75⅞ | .81¾ | .71 | .75¾ | .68⅝ | .75⅜ | .71¼ | .78 | .69⅝ | .75 | .65⅞ | .71¾ | 1.05 | 1.10 |
| August | .74⅝ | .78¼ | .71 | .73¼ | .69 | .74½ | .70 | .74 | .68⅛ | .73¼ | .66 | .70¼ | 1.03¾ | 1.07½ |
| September | .73¾ | .77⅝ | .70½ | .74½ | .69⅜ | .75⅛ | .70½ | .73½ | .68 | .72 | .64⅞ | .67⅞ | 1.02½ | 1.07½ |
| October | .75 | .78¾ | .71 | .75½ | .68⅜ | .74¾ | .70½ | .73⅜ | .69½ | .73 | .64¾ | .69½ | 1.07½ | 1.12½ |
| November | .72¼ | .75⅝ | .68½ | .72 | .65 | .71½ | .67½ | .70¾ | .68½ | .70½ | .61¾ | .64 | .97½ | 1.07½ |
| December | .72⅛ | .76 | .70 | .72 | .64 | .69½ | .68 | .72 | .69½ | .72 | .60 | .64 | .96¼ | .98¾ |
| **1900.** | | | | | | | | | | | No. 1, northern. | | | |
| January | .72⅞ | .78⅜ | .70 | .73 | .61½ | .67⅛ | .66¾ | .72 | .66¼ | .72 | .62 | .66¼ | .95 | .98¾ |
| February | .74¾ | .79⅞ | .73 | .76 | .63⅞ | .67½ | .70¾ | .73¼ | .69 | .71¾ | .63 | .65⅞ | .96¼ | 1.00 |
| March | .74½ | .81⅜ | .71½ | .75½ | .64 | .67 | .70¼ | .72½ | .69 | .72¼ | .63⅛ | .66 | .95 | .96¼ |
| April | .78 | .81¼ | .71½ | .76 | .64¾ | .67¾ | .71 | .72¾ | .70 | .72¾ | .64½ | .66⅛ | .95 | .96¼ |
| May | .78 | .82¾ | .72 | .73½ | .63⅝ | .67½ | .71¾ | .74 | .70¼ | .71¼ | .64½ | .66⅛ | .90 | .95 |
| June | .80 | .96⅞ | .72 | .90 | .65⅞ | .87½ | .73¼ | .91½ | .68¾ | .86½ | .64⅞ | .88⅞ | .91¼ | 1.07½ |
| July | .81 | .90¼ | .73 | .81½ | .74 | .81½ | .77½ | .84½ | .71⅞ | .80⅛ | .74¾ | .82¼ | 1.05 | 1.07½ |
| August | .78¼ | .83⅜ | .71 | .76 | .71¾ | .76¼ | .74 | .78¾ | .68¾ | .73 | .72¼ | .76 | 1.02½ | 1.05 |
| September | .79¼ | .85 | .71¾ | .77 | .72½ | .79⅜ | .75¼ | .80¾ | .71 | .77½ | .73½ | .81¼ | 1.03¾ | 1.05 |
| October | .76⅞ | .82⅞ | .71¼ | .77 | .71⅜ | .77⅜ | .75 | .79½ | .69 | .75½ | .73⅞ | .80¼ | .95 | 1.01¼ |
| November | .77½ | .81¼ | .71¾ | .73¾ | .69⅝ | .74¼ | .74¼ | .77½ | .69½ | .72¾ | .72¾ | .76⅝ | .97½ | 1.00 |
| December | .77⅜ | .83⅛ | .71½ | .75½ | .69¼ | .74⅝ | .74½ | .81 | .69¾ | .71¼ | .71⅞ | .75¼ | .96¼ | .97½ |

*Transportation rates, average for wheat, in cents, St. Louis to New Orleans by river.*

| Year. | Bulk, per bushel. | Sacks, per 100 lbs. | Year. | Bulk, per bushel. | Sacks, per 100 lbs. | Year. | Bulk, per bushel. | Sacks, per 100 lbs. | Year. | Bulk, per bushel. | Sacks, per 100 lbs. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1877 | 8.11 | 20.04 | 1883 | 5.50 | 17.75 | 1889 | 5.95 | 17.93 | 1895 | 5.95 | 12.50 |
| 1878 | 7.19 | 17.36 | 1884 | 6.63 | 14.00 | 1890 | 6.58 | 15.66 | 1896 | 5.00 | 14.55 |
| 1879 | 7.75 | 18.00 | 1885 | 6.40 | 15.00 | 1891 | 6.88 | 16.28 | 1897 | 4.98 | 15.00 |
| 1880 | 8.25 | 19.00 | 1886 | 6.50 | 16.00 | 1892 | 6.50 | 16.87 | 1898 | 4.50 | 10.00 |
| 1881 | 6.00 | 20.00 | 1887 | 6.00 | 18.25 | 1893 | 6.55 | 17.54 | 1899 | 4.50 | 10.00 |
| 1882 | 6.42 | 20.00 | 1888 | 6.50 | 15.00 | 1894 | 5.89 | 17.14 | 1900 | 4.25 | 10.00 |

## OATS.

The oat crop of 1900 for the world was 3,120,100,000, the largest for the past five years except that of 1899, which, in round numbers, was 116,000,000 bushels greater.

The condition of the crop in the United States for the growing season, as reported by the Division of Statistics, promised rather less than in any one of the years under consideration, but the outcome was better than these reports indicated. The yield per acre was 29.6 bushels, against 25.7 in 1896, 27.2 in 1897, and 28.4 in 1898. As compared with 1899, the outlook tallied more nearly with the result, for the average yield that year was 30.2 bushels per acre.

The total crop in 1900 for the United States was 809,125,989 bushels, and it sold on the farm, in spite of the two big crops coming together, at a better average price than had been secured at any time since 1894. The result was a gross return to farmers of $10,500,000 better than in 1899, the best previous record since 1894. The Chicago price, however, was not so good as in the two years next preceding, though equal to 1897 and 5 cents a bushel better than 1895 and 1896. The range of wholesale prices for the year in the leading markets was unusually small. The variation in Chicago was from 26¼ cents in June to 21 cents in August, with no change beyond a small fraction for the succeeding months. On no other market was the range comparatively greater, and nearly everywhere it was even smaller. In San Francisco the figures had a variation of 17½ cents, but as the price is about $1.30 per bushel this is hardly to be considered more important than the change of 5¼ cents at Chicago on a price of 24 cents a bushel. Freight rates for the year were about unchanged.

Two States, Illinois and Iowa, produce nearly one-third of the oat crop in the United States, and the adjoining States of Indiana, Michigan, Wisconsin, Minnesota, Kansas, Nebraska, and Missouri, with Ohio, make up more than half the remainder. The crop in these ten States in 1900 was 592,000,000 bushels, out of a total for the country of 809,125,989 bushels. The only other States having important oat crops are Pennsylvania, New York, and Texas, and of these only Texas has a considerable export crop. Of the marketed crop of 242,850,477 bushels in 1900, much over half, 133,500,000 bushels in round numbers, came from Illinois and Iowa, and 85,000,000 of the remainder from the group of States adjoining. These States, except Minnesota, show a slight upward trend in yield per acre in the past ten years, while Texas shows a decided gain in this respect.

In values per acre there was in 1900 an advance over 1899 in every important oat-producing State except New York, Pennsylvania, Minnesota, and Nebraska. In this respect Texas again shows the most notable advance, going from $7.50 to $11.40.

The exports showed a gain of 11,059,637 bushels and $2,717,114. The average export price declined from 32.3 cents to 30.2 cents a bushel.

*Oat crops of the countries named, 1896–1900.*

| Countries. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| United States | 707,346,000 | 698,768,000 | 730,907,000 | 796,178,000 | 809,126,000 |
| Ontario | 85,595,000 | 89,038,000 | 89,596,000 | 92,731,000 | 92,520,000 |
| Manitoba | 12,896,000 | 10,965,000 | 17,854,000 | 23,022,000 | 9,092,000 |
| Rest of Canada | 9,000,000 | 12,000,000 | 13,000,000 | 14,000,000 | 12,000,000 |
| Total Canada | 107,491,000 | 112,003,000 | 120,450,000 | 129,753,000 | 113,612,000 |
| Total North America | 814,837,000 | 810,771,000 | 851,357,000 | 925,931,000 | 922,738,000 |
| Great Britain | 117,609,000 | 120,530,000 | 122,669,000 | 118,363,000 | 118,467,000 |
| Ireland | 50,383,000 | 48,181,000 | 55,348,000 | 53,013,000 | 51,875,000 |
| Total United Kingdom | 167,992,000 | 168,711,000 | 178,017,000 | 171,376,000 | 170,342,000 |

*Oat crop of the countries named, 1896–1900*—Continued.

| Countries. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| Sweden | 56,090,000 | 58,473,000 | 70,416,000 | 53,698,000 | 69,272,000 |
| Denmark | 38,521,000 | 35,220,000 | 41,474,000 | 37,074,000 | 35,000,000 |
| Netherlands | 15,340,000 | 16,125,000 | 16,618,000 | 15,800,000 | 16,000,000 |
| Belgium | 26,196,000 | 29,591,000 | 23,417,000 | 17,000,000 | 20,000,000 |
| France | 261,078,000 | 227,595,000 | 278,277,000 | 270,437,000 | 252,878,000 |
| Spain | 7,844,000 | 10,751,000 | 8,833,000 | 12,776,000 | 9,500,000 |
| Italy | 22,265,000 | 19,599,000 | 18,567,000 | 16,504,000 | 16,000,000 |
| Germany | 411,263,000 | 393,983,000 | 465,321,000 | 474,179,000 | 488,594,000 |
| Austria | 104,220,000 | 96,164,000 | 114,189,000 | 122,168,000 | 116,000,000 |
| Hungary | 69,930,000 | 52,644,000 | 71,986,000 | 74,011,000 | 71,000,000 |
| Croatia-Slavonia | 4,820,000 | 4,035,000 | 6,215,000 | 5,623,000 | 6,000,000 |
| Total Austria-Hungary | 178,970,000 | 152,843,000 | 192,390,000 | 201,802,000 | 193,000,000 |
| Roumania | 14,720,000 | 9,852,000 | 17,410,000 | 6,255,000 | 8,684,000 |
| Bulgaria | 9,000,000 | 8,000,000 | 10,662,000 | 5,775,000 | 8,000,000 |
| Russia proper | 668,973,000 | 547,323,000 | 559,920,000 | 839,639,000 | 744,037,000 |
| Poland | 47,794,000 | 41,585,000 | 55,515,000 | 56,463,000 | 51,235,000 |
| North Caucasus | 12,201,000 | 6,695,000 | 12,416,000 | 12,546,000 | 17,519,000 |
| Total Russia in Europe | 728,968,000 | 595,603,000 | 627,851,000 | 908,648,000 | 812,791,000 |
| Total Europe | 1,938,247,000 | 1,726,346,000 | 1,949,253,000 | 2,191,324,000 | 2,100,061,000 |
| Siberia | 60,733,000 | 59,550,000 | 51,258,000 | 76,853,000 | 34,918,000 |
| Central Asia | 10,131,000 | 8,559,000 | 8,423,000 | 9,804,000 | 5,987,000 |
| Total Russia in Asia | 70,864,000 | 68,109,000 | 59,681,000 | 86,657,000 | 40,905,000 |
| Total Asia | 70,864,000 | 68,109,000 | 59,681,000 | 86,657,000 | 40,905,000 |
| Algeria | 4,486,000 | 4,092,000 | 6,023,000 | 4,534,000 | 5,000,000 |
| Cape Colony | 1,707,000 | 936,000 | 1,493,000 | 1,868,000 | 1,500,000 |
| Total Africa | 6,193,000 | 5,028,000 | 7,516,000 | 6,402,000 | 6,500,000 |
| West Australia | 20,000 | 19,000 | 30,000 | 58,000 | 76,000 |
| South Australia | (1) | 196,000 | 211,000 | 314,000 | 225,000 |
| Queensland | 11,000 | 33,000 | 32,000 | 4,000 | 11,000 |
| New South Wales | 386,000 | 861,000 | 561,000 | 287,000 | 648,000 |
| Victoria | 2,971,000 | 7,032,000 | 4,961,000 | 5,697,000 | 6,309,000 |
| Tasmania | 936,000 | 1,003,000 | 1,137,000 | 2,343,000 | 1,184,000 |
| New Zealand | 12,650,000 | 11,587,000 | 10,045,000 | 17,032,000 | 16,840,000 |
| Total Australasia | 16,974,000 | 20,731,000 | 16,977,000 | 25,735,000 | 25,293,000 |

RECAPITULATION BY CONTINENTS.

| | | | | | |
|---|---|---|---|---|---|
| North America | 814,837,000 | 810,771,000 | 851,357,000 | 925,931,000 | 922,738,000 |
| Europe | 1,938,247,000 | 1,726,346,000 | 1,949,253,000 | 2,191,324,000 | 2,100,061,000 |
| Asia | 70,864,000 | 68,109,000 | 59,681,000 | 86,657,000 | 40,905,000 |
| Africa | 6,193,000 | 5,028,000 | 7,516,000 | 6,402,000 | 6,500,000 |
| Australasia | 16,974,000 | 20,731,000 | 16,977,000 | 25,735,000 | 25,293,000 |
| Total | 2,847,115,000 | 2,630,985,000 | 2,884,784,000 | 3,236,049,000 | 3,095,497,000 |

[1] No returns.

*Visible supply of oats the first of each month for ten years.*

| Month. | 1891–1892. | 1892–1893. | 1893–1894. | 1894–1895. | 1895–1896. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| July | 4,651,638 | 6,774,710 | 4,805,000 | 3,134,000 | 9,007,000 |
| August | 2,432,000 | 6,889,000 | 2,627,000 | 2,135,000 | 4,653,000 |
| September | 4,275,270 | 7,267,947 | 4,846,000 | 9,380,000 | 4,673,000 |
| October | 7,798,200 | 9,459,287 | 5,324,000 | 10,765,000 | 4,124,000 |
| November | 6,627,893 | 11,712,481 | 7,252,000 | 12,738,000 | 8,020,000 |
| December | 7,013,359 | 10,996,628 | 6,602,000 | 12,332,000 | 10,248,000 |
| January | 6,601,065 | 9,808,597 | 5,602,000 | 11,864,000 | 10,446,000 |
| February | 5,081,349 | 9,282,000 | 5,371,000 | 10,508,000 | 11,446,000 |
| March | 6,600,023 | 8,618,000 | 4,089,000 | 9,227,000 | 12,211,000 |
| April | 6,576,511 | 7,174,000 | 3,938,000 | 8,905,000 | 14,326,000 |
| May | 5,337,832 | 6,168,000 | 3,761,000 | 7,823,000 | 13,426,000 |
| June | 4,271,020 | 5,839,000 | 3,401,000 | 11,284,000 | 13,460,000 |

*Visible supply of oats the first of each month for ten years*—Continued.

| Month. | 1896-1897. | 1897-1898. | 1898-1899. | 1899-1900. | 1900-1901. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| July | 14,120,000 | 12,912,000 | 8,716,000 | 10,262,000 | 12,716,000 |
| August | 10,384,000 | 9,604,000 | 4,971,000 | 6,885,000 | 9,364,000 |
| September | 11,410,000 | 13,784,000 | 7,360,000 | 10,973,000 | 13,853,000 |
| October | 13,821,000 | 15,573,000 | 9,286,000 | 13,127,000 | 17,140,000 |
| November | 17,217,000 | 20,096,000 | 11,352,000 | 13,254,000 | 20,528,000 |
| December | 17,995,000 | 19,768,000 | 9,460,000 | 11,789,000 | 18,136,000 |
| January | 19,538,000 | 16,148,000 | 10,893,000 | 12,004,000 | 15,861,000 |
| February | 19,978,000 | 20,245,000 | 13,231,000 | 11,876,000 | 16,175,000 |
| March | 20,832,000 | 17,925,000 | 14,782,000 | 12,449,000 | 16,800,000 |
| April | 20,672,000 | 15,609,000 | 15,725,000 | 14,176,000 | 15,823,000 |
| May | 16,138,000 | 14,402,000 | 13,971,000 | 13,845,000 | ........ |
| June | 12,878,000 | 10,421,000 | 13,661,000 | 12,301,000 | ........ |

*Condition of oat crop of United States, 1886–1900.*

| Year. | June. | July. | August. | September. | Year. | June. | July. | August. | September. | Year. | June. | July. | August. | September. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1886 | 95.9 | 88.8 | 87.4 | 90.9 | 1891 | 85.1 | 87.6 | 89.5 | 90.7 | 1896 | 98.8 | 96.3 | 77.3 | 74.0 |
| 1887 | 91.0 | 85.9 | 85.6 | 83.4 | 1892 | 88.5 | 87.2 | 86.2 | 78.9 | 1897 | 89.0 | 87.5 | 86.0 | 84.6 |
| 1888 | 95.4 | 95.2 | 91.7 | 87.2 | 1893 | 88.9 | 88.8 | 78.3 | 74.9 | 1898 | 98.0 | 92.8 | 84.2 | 79.0 |
| 1889 | 93.8 | 94.1 | 92.3 | 90.0 | 1894 | 87.0 | 77.7 | 76.5 | 77.8 | 1899 | 88.7 | 90.0 | 90.8 | 87.2 |
| 1890 | 89.8 | 81.6 | 70.1 | 64.4 | 1895 | 84.3 | 83.2 | 84.5 | 86.0 | 1900 | 91.7 | 85.5 | 85.0 | 82.9 |

*Acreage, production, value, prices, exports, and imports of oats of the United States, 1866 to 1900, inclusive.*

| Year. | Acreage. | Average yield per acre. | Production. | Average farm price per bushel, Dec. 1 | Farm value Dec. 1. | Chicago cash price per bushel, No. 2. December. Low. | December. High. | May of following year. Low. | May of following year. High. | Domestic exports, including oatmeal, fiscal years beginning July 1.[1] | Imports during fiscal years beginning July 1.[1] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Acres.* | *Bush.* | *Bushels.* | *Cts.* | *Dollars.* | *Cts.* | *Cts.* | *Cts.* | *Cts.* | *Bushels.* | *Bushels.* |
| 1866 | 8,864,219 | 30.2 | 268,141,078 | 35.1 | 94,057,945 | 36 | 43 | 59 | 78 | 825,895 | 778,198 |
| 1867 | 10,746,416 | 25.9 | 278,698,000 | 44.5 | 123,902,556 | 52 | 57¼ | ...... | ...... | 122,554 | 780,798 |
| 1868 | 9,665,736 | 26.4 | 254,960,800 | 41.7 | 106,355,976 | 43 | 49½ | 56¾ | 62½ | 481,871 | 326,659 |
| 1869 | 9,461,441 | 30.5 | 288,334,000 | 38.0 | 109,521,734 | 40 | 44¾ | 46½ | 53½ | 121,517 | 2,266,785 |
| 1870 | 8,792,395 | 28.1 | 247,277,400 | 39.0 | 96,443,637 | 37¾ | 41 | 47¼ | 51 | 147,572 | 599,514 |
| 1871 | 8,365,809 | 30.6 | 255,743,000 | 36.2 | 92,591,359 | 30¾ | 33 | 34¾ | 42½ | 262,975 | 535,250 |
| 1872 | 9,000,769 | 30.2 | 271,747,000 | 29.9 | 81,303,518 | 23½ | 25¾ | 30 | 34 | 714,072 | 225,555 |
| 1873 | 9,751,700 | 27.7 | 270,340,000 | 34.6 | 93,474,161 | 34 | 40⅝ | 44 | 48½ | 812,873 | 191,802 |
| 1874 | 10,897,412 | 22.1 | 240,369,000 | 47.1 | 113,133,934 | 51¾ | 54½ | 57¼ | 64½ | 504,770 | 1,500,040 |
| 1875 | 11,915,075 | 29.7 | 354,317,500 | 32.0 | 113,441,491 | 29½ | 30½ | 28⅝ | 31½ | 1,466,228 | 121,547 |
| 1876 | 13,358,908 | 24.0 | 320,884,000 | 32.4 | 103,844,896 | 31¾ | 34½ | 37¼ | 45¾ | 2,854,128 | 41,597 |
| 1877 | 12,826,148 | 31.7 | 406,394,000 | 28.4 | 115,546,194 | 24⅛ | 27 | 23 | 27 | 3,715,479 | 21,391 |
| 1878 | 13,176,500 | 31.4 | 413,578,560 | 24.6 | 101,752,468 | 19⅝ | 20⅜ | 24⅜ | 30½ | 5,452,136 | 13,395 |
| 1879 | 12,683,500 | 28.7 | 363,761,320 | 33.1 | 120,533,294 | 32¾ | 36¾ | 29½ | 34⅞ | 766,366 | 489,576 |
| 1880 | 16,187,977 | 25.8 | 417,885,380 | 36.0 | 150,243,565 | 29⅛ | 33½ | 36¼ | 39½ | 402,904 | 64,412 |
| 1881 | 16,831,600 | 24.7 | 416,481,000 | 46.4 | 193,198,970 | 43½ | 46¾ | 48¾ | 56⅜ | 625,690 | 1,850,983 |
| 1882 | 18,494,691 | 26.4 | 488,250,610 | 37.5 | 182,978,022 | 34¾ | 41½ | 38¾ | 42¾ | 461,496 | 815,017 |
| 1883 | 20,324,962 | 28.1 | 571,302,400 | 32.7 | 187,040,264 | 29⅜ | 36⅛ | 30¾ | 34¼ | 3,274,622 | 121,069 |
| 1884 | 21,300,917 | 27.4 | 583,628,000 | 27.7 | 161,528,470 | 22½ | 25¼ | 34½ | 37 | 6,203,104 | 94,310 |
| 1885 | 22,783,630 | 27.6 | 629,409,000 | 28.5 | 179,631,860 | 27 | 29 | 26¼ | 29⅝ | 7,311,306 | 149,480 |
| 1886 | 23,658,474 | 26.4 | 624,134,000 | 29.8 | 186,137,930 | 25¾ | 27¼ | 25⅛ | 27½ | 1,374,635 | 139,575 |
| 1887 | 25,920,906 | 25.4 | 659,618,000 | 30.4 | 200,699,790 | 28⅝ | 30⅞ | 32½ | 38 | 573,080 | 123,817 |
| 1888 | 26,998,282 | 26.0 | 701,735,000 | 27.8 | 195,424,240 | 25 | 26⅞ | 21⅝ | 23⅝ | 1,191,471 | 131,501 |
| 1889 | 27,462,316 | 27.4 | 751,515,000 | 22.9 | 171,781,008 | 20 | 21 | 24¾ | 30 | 15,107,238 | 153,232 |
| 1890 | 26,431,369 | 19.8 | 523,621,000 | 42.4 | 222,048,486 | 39⅞ | 43⅞ | 45¼ | 54 | 1,382,836 | 41,848 |
| 1891 | 25,581,861 | 28.9 | 738,394,000 | 31.5 | 232,312,267 | 31⅛ | 33⅝ | 28⅛ | 33½ | 10,586,644 | 47,782 |
| 1892 | 27,063,835 | 24.4 | 661,035,000 | 31.7 | 209,253,611 | 25⅝ | 31¼ | 28¾ | 32¼ | 2,700,793 | 49,433 |
| 1893 | 27,273,033 | 23.4 | 638,854,850 | 29.4 | 187,576,092 | 27½ | 29⅛ | 32½ | 36 | 6,290,229 | 31,759 |
| 1894 | 27,023,553 | 24.5 | 662,036,928 | 32.4 | 214,816,920 | 28¾ | 29⅜ | 27½ | 30¾ | 1,708,824 | 330,318 |
| 1895 | 27,878,406 | 29.6 | 824,443,537 | 19.9 | 163,655,068 | 16⅝ | 17½ | 18 | 19⅝ | 15,156,618 | 66,602 |
| 1896 | 27,565,985 | 25.7 | 707,346,404 | 18.7 | 132,485,033 | 16½ | 18¾ | 16⅞ | 18¾ | 37,725,083 | 131,204 |
| 1897 | 25,730,375 | 27.2 | 698,767,809 | 21.2 | 147,974,719 | 21 | 23⅞ | 26 | 32 | 73,880,307 | 25,093 |
| 1898 | 25,777,110 | 28.4 | 730,906,643 | 25.5 | 186,405,364 | 26 | 27¾ | 24 | 27¾ | 33,534,362 | 28,098 |
| 1899 | 26,341,380 | 30.2 | 796,177,713 | 24.9 | 198,167,975 | 22¼ | 23 | 21¼ | 23¾ | 45,049,202 | 54,451 |
| 1900 | 27,364,795 | 29.6 | 809,125,989 | 25.8 | 208,669,233 | 21¾ | 22¾ | ...... | ...... | ........ | ........ |

[1] In years 1866 to 1882, inclusive, oatmeal is not included.

*Acreage, production, value, and distribution of oats of the United States in 1900, by States.*

| States and Territories. | Crop of 1900. | | | Stock on hand March 1, 1900. | | Shipped out of county where grown. |
|---|---|---|---|---|---|---|
| | Acreage. | Production. | Value. | | | |
| | *Acres.* | *Bushels.* | *Dollars.* | *Bushels.* | *Per cent.* | *Bushels.* |
| Maine | 140,203 | 5,257,612 | 1,997,893 | 1,945,316 | 37 | 105,152 |
| New Hampshire | 30,526 | 995,148 | 378,156 | 278,641 | 28 | 9,951 |
| Vermont | 106,581 | 3,719,677 | 1,339,084 | 1,264,690 | 34 | 0 |
| Massachusetts | 14,967 | 550,786 | 209,299 | 137,696 | 25 | 0 |
| Rhode Island | 3,705 | 114,484 | 43,504 | 33,200 | 29 | 0 |
| Connecticut | 18,677 | 578,987 | 202,645 | 144,747 | 25 | 0 |
| New York | 1,596,379 | 44,538,974 | 14,252,472 | 18,706,369 | 42 | 2,226,949 |
| New Jersey | 95,003 | 2,812,089 | 871,748 | 843,627 | 30 | 337,451 |
| Pennsylvania | 1,221,893 | 38,000,872 | 11,400,262 | 15,960,366 | 42 | 2,660,061 |
| Delaware | 15,844 | 332,724 | 99,817 | 109,799 | 33 | 53,236 |
| Maryland | 74,309 | 1,783,416 | 552,859 | 410,186 | 23 | 249,678 |
| Virginia | 349,160 | 5,167,568 | 1,912,000 | 1,446,919 | 28 | 310,054 |
| North Carolina | 363,030 | 5,046,117 | 2,270,753 | 1,110,146 | 22 | 201,845 |
| South Carolina | 259,558 | 4,023,149 | 1,931,112 | 402,315 | 10 | 120,684 |
| Georgia | 467,336 | 7,010,040 | 3,434,920 | 1,121,606 | 16 | 140,201 |
| Florida | 33,470 | 378,211 | 189,106 | 64,296 | 17 | 11,346 |
| Alabama | 304,219 | 4,380,754 | 1,927,532 | 613,306 | 14 | 87,615 |
| Mississippi | 170,718 | 2,390,052 | 1,099,424 | 286,806 | 12 | 23,901 |
| Louisiana | 34,119 | 614,142 | 245,657 | 110,546 | 18 | 12,283 |
| Texas | 744,164 | 28,278,232 | 8,483,470 | 6,786,776 | 24 | 6,786,776 |
| Arkansas | 317,057 | 7,038,665 | 2,463,533 | 2,111,600 | 30 | 492,707 |
| Tennessee | 350,010 | 5,810,166 | 2,033,558 | 1,452,542 | 25 | 581,017 |
| West Virginia | 131,831 | 2,768,451 | 941,273 | 941,273 | 34 | 166,107 |
| Kentucky | 437,056 | 9,309,293 | 2,885,881 | 3,165,160 | 34 | 651,651 |
| Ohio | 1,061,593 | 40,340,534 | 10,488,539 | 15,732,808 | 39 | 10,488,539 |
| Michigan | 917,971 | 33,689,536 | 8,759,279 | 14,486,500 | 43 | 9,433,070 |
| Indiana | 1,372,050 | 44,866,035 | 10,319,188 | 14,805,792 | 33 | 17,946,414 |
| Illinois | 3,516,918 | 133,642,884 | 30,737,863 | 52,120,725 | 39 | 73,503,586 |
| Wisconsin | 1,936,611 | 61,971,552 | 14,253,457 | 27,267,483 | 44 | 15,492,888 |
| Minnesota | 1,662,978 | 41,907,046 | 10,057,691 | 16,762,818 | 40 | 8,381,409 |
| Iowa | 3,840,357 | 130,572,138 | 26,114,428 | 44,394,527 | 34 | 60,063,183 |
| Missouri | 901,291 | 24,695,373 | 5,679,936 | 9,137,288 | 37 | 4,198,213 |
| Kansas | 1,362,783 | 43,063,943 | 9,904,707 | 16,364,298 | 38 | 8,612,789 |
| Nebraska | 1,732,962 | 37,778,572 | 9,066,857 | 10,578,000 | 28 | 12,466,929 |
| South Dakota | 588,524 | 12,653,266 | 3,036,784 | 4,934,774 | 39 | 2,024,523 |
| North Dakota | 611,581 | 6,299,284 | 2,015,771 | 1,889,785 | 30 | 629,928 |
| Montana | 65,865 | 2,568,735 | 1,078,869 | 1,078,869 | 42 | 667,871 |
| Wyoming | 18,429 | 630,272 | 296,228 | 151,265 | 24 | 37,816 |
| Colorado | 99,768 | 3,272,390 | 1,407,128 | 1,145,336 | 35 | 785,384 |
| New Mexico | 7,641 | 229,994 | 110,397 | 45,999 | 20 | 55,199 |
| Utah | 25,577 | 918,214 | 404,014 | 156,096 | 17 | 247,918 |
| Idaho | 36,881 | 1,349,845 | 539,938 | 391,455 | 29 | 391,455 |
| Washington | 87,681 | 3,016,226 | 1,206,490 | 693,732 | 23 | 1,206,490 |
| Oregon | 177,447 | 3,282,770 | 1,345,936 | 952,003 | 29 | 722,209 |
| California | 60,072 | 1,477,771 | 679,775 | 265,999 | 18 | 265,999 |
| United States | 27,364,795 | 809,125,989 | 208,669,233 | 292,803,480 | 36.2 | 242,850,477 |

*Average yield per acre of oats in the United States, 1891-1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* |
| Maine | 34.6 | 32.2 | 36.3 | 33.5 | 40.1 | 40.0 | 31.0 | 36.0 | 35.0 | 37.5 |
| New Hampshire | 35.0 | 34.0 | 34.2 | 31.1 | 36.9 | 38.0 | 35.0 | 33.0 | 35.0 | 32.6 |
| Vermont | 37.5 | 35.5 | 36.4 | 32.9 | 43.8 | 40.5 | 33.0 | 38.0 | 37.0 | 34.9 |
| Massachusetts | 33.0 | 30.4 | 34.3 | 31.9 | 36.0 | 36.0 | 32.0 | 32.0 | 33.0 | 36.8 |
| Rhode Island | 33.5 | 29.4 | 28.2 | 30.0 | 32.4 | 30.0 | 32.0 | 27.0 | 26.0 | 30.9 |
| Connecticut | 30.0 | 25.3 | 25.0 | 25.8 | 31.9 | 29.0 | 29.0 | 28.2 | 28.0 | 31.0 |
| New York | 31.5 | 28.0 | 24.0 | 22.1 | 31.7 | 33.0 | 31.0 | 27.5 | 31.0 | 27.9 |
| New Jersey | 28.0 | 25.7 | 23.9 | 28.4 | 35.5 | 34.0 | 25.0 | 19.6 | 24.0 | 29.6 |
| Pennsylvania | 27.2 | 25.2 | 26.8 | 22.3 | 31.7 | 31.0 | 28.2 | 23.3 | 33.0 | 31.1 |
| Delaware | 20.3 | 19.3 | 25.4 | 19.0 | 19.1 | 29.0 | 22.0 | 22.0 | 20.0 | 21.0 |
| Maryland | 19.0 | 19.0 | 21.2 | 21.4 | 26.2 | 24.0 | 24.0 | 19.5 | 23.0 | 24.0 |
| Virginia | 10.7 | 11.2 | 17.5 | 12.0 | 17.7 | 18.5 | 12.0 | 16.1 | 14.0 | 14.8 |
| North Carolina | 9.5 | 9.7 | 14.1 | 10.9 | 15.1 | 12.0 | 13.0 | 14.3 | 12.0 | 13.9 |
| South Carolina | 10.6 | 10.5 | 11.8 | 12.0 | 15.2 | 11.0 | 15.5 | 17.2 | 12.0 | 15.5 |
| Georgia | 11.7 | 10.7 | 13.3 | 13.4 | 14.5 | 12.0 | 14.0 | 16.6 | 9.0 | 15.0 |
| Florida | 11.4 | 9.8 | 11.8 | 11.8 | 10.2 | 12.0 | 9.0 | 15.4 | 9.0 | 11.3 |
| Alabama | 12.8 | 10.2 | 14.2 | 13.2 | 14.9 | 14.0 | 13.0 | 16.8 | 10.0 | 14.4 |
| Mississippi | 11.5 | 10.6 | 15.5 | 13.0 | 15.7 | 13.0 | 14.0 | 18.5 | 10.0 | 14.0 |
| Louisiana | 12.3 | 12.2 | 16.0 | 22.3 | 15.0 | 10.0 | 18.0 | 18.1 | 18.0 | 18.0 |
| Texas | 24.5 | 24.5 | 25.1 | 32.7 | 20.7 | 20.0 | 25.0 | 29.7 | 25.0 | 38.0 |
| Arkansas | 16.5 | 15.7 | 19.3 | 18.5 | 25.4 | 16.0 | 17.0 | 22.8 | 19.0 | 22.2 |
| Tennessee | 9.7 | 13.5 | 18.4 | 14.6 | 22.5 | 16.5 | 10.0 | 18.7 | 14.0 | 16.6 |

*Average yield per acre of oats in the United States, 1891–1900, by States*—Continued.

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* |
| West Virginia | 17.3 | 17.5 | 23.5 | 18.5 | 23.4 | 24.0 | 20.0 | 19.5 | 23.0 | 21.0 |
| Kentucky | 18.5 | 18.3 | 22.2 | 21.0 | 26.2 | 21.0 | 18.0 | 22.4 | 18.0 | 21.3 |
| Ohio | 31.3 | 26.3 | 28.6 | 30.3 | 31.7 | 31.0 | 32.0 | 30.9 | 36.0 | 38.0 |
| Michigan | 32.5 | 28.7 | 26.0 | 26.1 | 23.9 | 30.0 | 26.0 | 32.8 | 34.0 | 36.7 |
| Indiana | 23.5 | 26.5 | 27.5 | 32.3 | 22.9 | 29.0 | 30.2 | 29.2 | 32.0 | 32.7 |
| Illinois | 36.2 | 26.3 | 27.2 | 36.1 | 24.4 | 28.0 | 32.0 | 29.0 | 38.0 | 38.0 |
| Wisconsin | 33.3 | 30.2 | 27.6 | 32.9 | 33.8 | 33.4 | 34.0 | 36.1 | 36.0 | 32.0 |
| Minnesota | 36.5 | 27.3 | 24.8 | 28.1 | 39.9 | 33.0 | 26.0 | 36.3 | 32.0 | 25.2 |
| Iowa | 36.7 | 25.4 | 24.8 | 25.6 | 46.2 | 27.5 | 30.0 | 34.0 | 33.0 | 34.0 |
| Missouri | 23.8 | 20.0 | 23.4 | 23.3 | 27.7 | 18.0 | 22.0 | 17.0 | 25.0 | 27.4 |
| Kansas | 30.0 | 28.5 | 18.5 | 17.9 | 17.9 | 13.0 | 24.0 | 18.0 | 29.0 | 31.6 |
| Nebraska | 35.5 | 26.7 | 15.0 | 12.6 | 23.8 | 19.0 | 31.0 | 32.1 | 30.0 | 21.8 |
| South Dakota | 32.3 | 26.3 | 21.5 | 7.6 | 25.3 | 27.5 | 22.0 | 26.8 | 26.0 | 21.5 |
| North Dakota | 33.5 | 26.5 | 21.9 | 25.9 | 32.1 | 22.0 | 23.0 | 30.7 | 30.0 | 10.3 |
| Montana | 38.5 | 28.8 | 34.0 | 40.1 | 35.8 | 47.0 | 42.0 | 40.6 | 38.0 | 39.0 |
| Wyoming | ...... | 28.6 | 24.0 | 30.4 | 41.0 | 32.0 | 35.0 | 31.2 | 30.0 | 34.2 |
| Colorado | 32.6 | 28.7 | 26.7 | 13.5 | 34.3 | 28.0 | 34.0 | 35.8 | 27.0 | 32.8 |
| New Mexico | 22.0 | 20.3 | 29.2 | 35.0 | 39.9 | 27.0 | 35.5 | 38.8 | 24.0 | 30.1 |
| Utah | 32.5 | 26.5 | 27.9 | 33.0 | 33.8 | 38.0 | 35.0 | 39.7 | 34.0 | 35.9 |
| Idaho | 35.0 | 29.0 | 33.1 | 38.5 | 35.2 | 42.0 | 36.3 | 43.6 | 34.0 | 36.6 |
| Washington | 38.0 | 34.5 | 39.7 | 36.5 | 40.3 | 36.0 | 48.0 | 41.9 | 37.0 | 34.4 |
| Oregon | 31.5 | 26.5 | 28.5 | 26.7 | 28.8 | 21.0 | 32.0 | 27.0 | 30.0 | 18.5 |
| California | 28.5 | 29.3 | 25.5 | 35.6 | 28.1 | 31.0 | 18.0 | 33.0 | 31.0 | 24.6 |
| General average | 28.86 | 24.43 | 23.42 | 24.50 | 29.57 | 25.66 | 27.16 | 28.35 | 30.23 | 29.6 |

*Average yield of oats in certain countries, in bushels per acre, 1894–1899.*

| Year. | United States. | Russia. | Germany. | Austria. | Hungary. | France. | United Kingdom. |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (2) | (1) | (1) | (1) | (1) |
| 1894 | 24.5 | 21.7 | 46.8 | 23.5 | 28.3 | 27.2 | 43.7 |
| 1895 | 29.6 | 19.9 | 43.2 | 23.7 | 28.3 | 27.5 | 39.5 |
| 1896 | 25.7 | 19.2 | 41.8 | 22.0 | 29.4 | 27.0 | 39.2 |
| 1897 | 27.2 | 15.7 | 39.9 | 20.3 | 23.1 | 23.1 | 40.1 |
| 1898 | 28.4 | 16.5 | 47.1 | 24.2 | 30.2 | 29.0 | 43.6 |
| 1899 | 30.2 | 23.6 | 48.0 | 26.5 | 30.3 | 27.8 | 41.8 |
| Average | 27.6 | 19.4 | 44.5 | 23.4 | 28.3 | 26.9 | 41.3 |

[1] Winchester bushels. [2] Bushels of 32 pounds.

*Average value per acre of oats in the United States, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| Maine | $15.57 | $14.49 | $16.34 | $14.74 | $13.63 | $12.40 | $9.92 | $12.24 | $13.30 | $14.25 |
| New Hampshire | 16.10 | 14.96 | 14.71 | 15.24 | 12.92 | 13.30 | 13.30 | 12.54 | 13.65 | 12.39 |
| Vermont | 15.38 | 15.26 | 15.29 | 16.78 | 14.37 | 12.56 | 10.56 | 13.30 | 13.69 | 12.56 |
| Massachusetts | 15.51 | 14.59 | 14.41 | 13.72 | 12.24 | 12.60 | 10.56 | 11.84 | 12.54 | 13.98 |
| Rhode Island | 15.74 | 14.46 | 12.13 | 14.10 | 12.64 | 9.30 | 10.88 | 9.99 | 9.62 | 11.74 |
| Connecticut | 13.50 | 11.38 | 10.00 | 11.09 | 9.89 | 8.99 | 9.86 | 10.15 | 10.36 | 10.85 |
| New York | 11.97 | 10.92 | 7.20 | 8.62 | 8.88 | 8.58 | 8.37 | 8.53 | 10.23 | 8.93 |
| New Jersey | 11.20 | 10.54 | 8.37 | 10.79 | 10.29 | 9.52 | 7.50 | 6.08 | 7.92 | 9.18 |
| Pennsylvania | 10.06 | 10.08 | 9.38 | 8.47 | 8.56 | 7.43 | 7.61 | 6.99 | 9.57 | 9.33 |
| Delaware | 7.92 | 7.33 | 9.65 | 6.65 | 5.54 | 6.09 | 5.06 | 6.60 | 5.00 | 6.30 |
| Maryland | 7.22 | 7.22 | 7.42 | 8.35 | 7.07 | 5.52 | 6.24 | 5.65 | 6.90 | 7.44 |
| Virginia | 4.39 | 4.37 | 6.13 | 4.44 | 5.31 | 4.81 | 3.48 | 4.67 | 4.62 | 5.48 |
| North Carolina | 4.85 | 4.37 | 6.20 | 4.80 | 5.74 | 4.20 | 4.81 | 5.29 | 4.92 | 6.26 |
| South Carolina | 6.47 | 5.46 | 6.25 | 6.36 | 7.45 | 5.28 | 6.98 | 7.74 | 5.64 | 7.44 |
| Georgia | 7.02 | 5.56 | 6.92 | 6.83 | 6.67 | 4.92 | 5.88 | 7.97 | 4.32 | 7.35 |
| Florida | 7.07 | 5.39 | 6.49 | 7.20 | 6.63 | 6.36 | 4.77 | 8.32 | 4.50 | 5.65 |
| Alabama | 7.68 | 5.20 | 7.24 | 6.73 | 6.26 | 5.74 | 5.59 | 6.89 | 4.30 | 6.34 |
| Mississippi | 6.67 | 5.30 | 7.28 | 6.11 | 6.12 | 5.72 | 6.16 | 7.77 | 5.00 | 6.44 |
| Louisiana | 6.40 | 6.10 | 7.04 | 10.48 | 5.40 | 3.40 | 6.84 | 6.88 | 7.20 | 7.20 |
| Texas | 11.52 | 9.31 | 10.54 | 12.75 | 5.38 | 6.80 | 6.75 | 8.32 | 7.50 | 11.40 |
| Arkansas | 6.93 | 6.28 | 7.53 | 7.40 | 8.13 | 4.96 | 5.61 | 6.61 | 6.46 | 7.77 |
| Tennessee | 3.88 | 5.13 | 5.70 | 5.11 | 6.08 | 4.29 | 2.80 | 5.24 | 4.48 | 5.81 |
| West Virginia | 6.92 | 7.18 | 8.93 | 7.21 | 7.49 | 6.72 | 6.00 | 5.85 | 8.05 | 7.14 |
| Kentucky | 6.84 | 6.77 | 7.55 | 7.56 | 6.81 | 5.04 | 4.86 | 6.05 | 5.76 | 6.60 |
| Ohio | 10.33 | 9.20 | 8.58 | 9.39 | 6.97 | 5.27 | 6.40 | 7.42 | 9.00 | 9.88 |

*Average value per acre of oats in the United States, 1891–1900, by States*—Continued.

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| Michigan | $10.40 | $10.05 | $8.32 | $8.87 | $5.50 | $5.70 | $5.98 | $8.86 | $9.52 | $9.54 |
| Indiana | 7.52 | 9.01 | 7.70 | 9.69 | 4.58 | 4.64 | 5.74 | 6.72 | 7.36 | 7.52 |
| Illinois | 10.14 | 8.15 | 7.34 | 10.47 | 4.15 | 4.20 | 5.76 | 6.67 | 8.36 | 8.74 |
| Wisconsin | 9.32 | 8.76 | 7.45 | 9.87 | 6.08 | 5.95 | 6.46 | 8.66 | 8.28 | 7.36 |
| Minnesota | 9.85 | 7.64 | 6.45 | 8.43 | 5.59 | 4.95 | 4.94 | 7.62 | 7.04 | 6.05 |
| Iowa | 9.54 | 6.60 | 5.70 | 7.17 | 6.47 | 3.30 | 4.80 | 8.16 | 6.27 | 6.80 |
| Missouri | 6.90 | 6.00 | 5.85 | 6.76 | 4.99 | 3.06 | 4.18 | 3.91 | 6.00 | 6.30 |
| Kansas | 8.10 | 7.41 | 5.00 | 5.55 | 3.04 | 2.08 | 4.32 | 3.96 | 6.38 | 7.27 |
| Nebraska | 8.16 | 6.14 | 3.30 | 4.54 | 3.33 | 2.09 | 4.65 | 6.42 | 6.60 | 5.23 |
| South Dakota | 8.08 | 6.05 | 5.37 | 2.65 | 4.35 | 3.58 | 3.96 | 5.63 | 5.98 | 5.16 |
| North Dakota | 8.71 | 7.42 | 6.13 | 7.51 | 5.14 | 3.96 | 5.98 | 7.98 | 8.10 | 3.30 |
| Montana | 18.48 | 11.52 | 12.58 | 12.43 | 15.75 | 14.57 | 13.86 | 14.21 | 14.82 | 16.38 |
| Wyoming | ...... | 10.87 | 9.60 | 14.59 | 15.99 | 16.96 | 12.25 | 12.48 | 12.00 | 16.07 |
| Colorado | 12.39 | 9.76 | 9.88 | 6.21 | 9.60 | 8.40 | 10.88 | 14.68 | 11.34 | 14.10 |
| New Mexico | 12.10 | 11.37 | 14.89 | 17.50 | 17.96 | 10.80 | 14.56 | 15.91 | 10.56 | 14.45 |
| Utah | 13.65 | 10.60 | 9.21 | 11.22 | 10.14 | 14.82 | 11.55 | 15.09 | 13.60 | 15.80 |
| Idaho | 17.50 | 10.73 | 13.57 | 12.32 | 10.21 | 12.60 | 11.62 | 15.70 | 12.92 | 14.64 |
| Washington | 15.58 | 12.07 | 13.90 | 11.32 | 11.28 | 14.40 | 16.80 | 16.76 | 14.06 | 13.76 |
| Oregon | 12.92 | 9.81 | 10.55 | 7.48 | 7.78 | 6.93 | 11.20 | 10.80 | 12.30 | 7.59 |
| California | 17.10 | 11.72 | 9.69 | 15.66 | 10.96 | 13.64 | 8.82 | 16.50 | 14.57 | 11.32 |
| General average | 9.08 | 7.73 | 6.88 | 7.95 | 5.87 | 4.81 | 5.75 | 7.23 | 7.52 | 7.63 |

*Average farm price of oats per bushel in the United States December 1, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| Maine | 45 | 45 | 45 | 44 | 34 | 31 | 32 | 34 | 38 | 38 |
| New Hampshire | 46 | 44 | 43 | 49 | 35 | 35 | 38 | 38 | 39 | 38 |
| Vermont | 41 | 43 | 42 | 51 | 33 | 31 | 32 | 35 | 37 | 36 |
| Massachusetts | 47 | 48 | 42 | 43 | 34 | 35 | 33 | 37 | 38 | 38 |
| Rhode Island | 47 | 49 | 43 | 47 | 39 | 31 | 34 | 37 | 37 | 38 |
| Connecticut | 45 | 45 | 40 | 43 | 31 | 31 | 34 | 36 | 37 | 35 |
| New York | 38 | 39 | 30 | 39 | 28 | 26 | 27 | 31 | 33 | 32 |
| New Jersey | 40 | 41 | 35 | 38 | 29 | 28 | 30 | 31 | 33 | 31 |
| Pennsylvania | 37 | 40 | 35 | 38 | 27 | 24 | 27 | 30 | 29 | 30 |
| Delaware | 39 | 38 | 38 | 35 | 29 | 21 | 23 | 30 | 25 | 30 |
| Maryland | 38 | 38 | 35 | 39 | 27 | 23 | 26 | 29 | 30 | 31 |
| Virginia | 41 | 39 | 35 | 37 | 30 | 26 | 29 | 29 | 33 | 37 |
| North Carolina | 51 | 45 | 44 | 44 | 38 | 35 | 37 | 37 | 41 | 45 |
| South Carolina | 61 | 52 | 53 | 53 | 49 | 48 | 45 | 45 | 47 | 48 |
| Georgia | 60 | 52 | 52 | 51 | 46 | 41 | 42 | 48 | 48 | 49 |
| Florida | 62 | 55 | 55 | 61 | 65 | 53 | 53 | 54 | 50 | 50 |
| Alabama | 60 | 51 | 51 | 51 | 42 | 41 | 43 | 41 | 43 | 44 |
| Mississippi | 58 | 50 | 47 | 47 | 39 | 44 | 44 | 42 | 50 | 46 |
| Louisiana | 52 | 50 | 44 | 47 | 36 | 34 | 38 | 38 | 40 | 40 |
| Texas | 47 | 38 | 42 | 39 | 26 | 34 | 27 | 28 | 30 | 30 |
| Arkansas | 42 | 40 | 39 | 40 | 32 | 31 | 33 | 29 | 34 | 35 |
| Tennessee | 40 | 38 | 31 | 35 | 27 | 26 | 28 | 28 | 32 | 35 |
| West Virginia | 40 | 41 | 38 | 39 | 32 | 28 | 30 | 30 | 35 | 34 |
| Kentucky | 37 | 37 | 34 | 36 | 26 | 24 | 27 | 27 | 32 | 31 |
| Ohio | 33 | 35 | 30 | 31 | 22 | 17 | 20 | 24 | 25 | 26 |
| Michigan | 32 | 35 | 32 | 34 | 23 | 19 | 23 | 27 | 28 | 26 |
| Indiana | 32 | 34 | 28 | 30 | 20 | 16 | 19 | 23 | 23 | 23 |
| Illinois | 28 | 31 | 27 | 29 | 17 | 15 | 18 | 23 | 22 | 23 |
| Wisconsin | 28 | 29 | 27 | 30 | 18 | 17 | 19 | 24 | 23 | 23 |
| Minnesota | 27 | 28 | 26 | 30 | 14 | 15 | 19 | 21 | 22 | 24 |
| Iowa | 26 | 26 | 23 | 28 | 14 | 12 | 16 | 24 | 19 | 20 |
| Missouri | 29 | 30 | 25 | 29 | 18 | 17 | 19 | 23 | 24 | 23 |
| Kansas | 27 | 26 | 27 | 31 | 17 | 16 | 18 | 22 | 22 | 23 |
| Nebraska | 23 | 23 | 22 | 36 | 14 | 11 | 15 | 20 | 22 | 24 |
| South Dakota | 25 | 23 | 25 | 35 | 17 | 13 | 18 | 21 | 23 | 24 |
| North Dakota | 26 | 28 | 28 | 29 | 16 | 18 | 26 | 26 | 27 | 32 |
| Montana | 48 | 40 | 37 | 31 | 44 | 31 | 33 | 35 | 39 | 42 |
| Wyoming | ...... | 38 | 40 | 48 | 39 | 53 | 35 | 40 | 40 | 47 |
| Colorado | 38 | 34 | 37 | 46 | 28 | 30 | 32 | 41 | 42 | 43 |
| New Mexico | 55 | 56 | 51 | 50 | 45 | 40 | 41 | 41 | 44 | 48 |
| Utah | 42 | 40 | 33 | 34 | 30 | 39 | 33 | 38 | 40 | 44 |
| Idaho | 50 | 37 | 41 | 32 | 29 | 30 | 32 | 36 | 38 | 40 |
| Washington | 41 | 35 | 35 | 31 | 28 | 40 | 35 | 40 | 38 | 40 |
| Oregon | 41 | 37 | 37 | 28 | 27 | 33 | 35 | 40 | 41 | 41 |
| California | 60 | 40 | 38 | 44 | 39 | 44 | 49 | 50 | 47 | 46 |
| General average | 31.46 | 31.66 | 29.36 | 32.45 | 19.85 | 18.73 | 21.18 | 25.50 | 24.89 | 25.8 |

*Wholesale prices of oats per bushel in leading cities of the United States, 1896–1900.*

| Date. | New York. | | Baltimore. | | Cincinnati. | | Chicago. | | Milwaukee. | | Duluth. | | Detroit. | | San Francisco. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. 2, mixed. | | No. 2, mixed. | | No. 2, mixed. | | No. 2. | | No. 2, white. | | No. 2. | | No. 2, white. | | No. 1, white (per cwt.). | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low | High. | Low. | High. | Low. | High. |
| **1896.** | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | | |
| January | 23¼ | 25 | 22½ | 23½ | 19¾ | 22 | 17 | 19½ | 18¼ | 21 | 15½ | 19 | 20½ | 23 | $0.75 | $0.80 |
| February | 24¾ | 25⅞ | 23½ | 27 | 21½ | 23 | 19¼ | 20¼ | 20 | 22 | 18 | 19 | 22½ | 23¾ | .72½ | .80 |
| March | 24¾ | 26 | 24½ | 26 | 21 | 22¾ | 18¼ | 20¼ | 19 | 21½ | 17½ | 19 | 22¼ | 23¾ | .72½ | .77½ |
| April | 24¾ | 25¾ | 24½ | 25 | 20¾ | 23 | 18¼ | 20 | 20 | 21½ | 17¼ | 19 | 21½ | 23½ | .77½ | .80 |
| May | 23 | 25½ | 24¼ | 25 | 20 | 22½ | 18 | 19⅝ | 19¼ | 21¼ | 17 | 20¾ | 21 | 23 | .77½ | .85 |
| June | 21½ | 23 | 20 | 24½ | 17 | 21¾ | 15¼ | 18½ | 18 | 20 | 15¼ | 19 | 18¾ | 22 | .82½ | .87½ |
| July | 20¼ | 22¾ | 20 | 25 | 17½ | 23 | 15 | 18½ | 17½ | 20¾ | 15¼ | 19½ | 19 | 23½ | .82½ | .87½ |
| August | 20½ | 23¾ | 23 | 25 | 17 | 21½ | 15¾ | 18½ | 18½ | 22 | 17¼ | 20¼ | 22 | 24¼ | .82½ | .87½ |
| September | 18¾ | 21 | 21 | 23½ | 15½ | 18½ | 14¾ | 17¼ | 16½ | 21 | 15¾ | 19¾ | 18½ | 22 | .87½ | .90 |
| October | 21 | 23¾ | 20½ | 23 | 17 | 20 | 17¼ | 19⅜ | 17 | 21½ | 17½ | 20½ | 20 | 22¼ | .90 | 1.07½ |
| November | 22⅝ | 24 | 22 | 23½ | 19 | 21½ | 17½ | 19¾ | 16½ | 22¼ | 17½ | 19 | 20¼ | 21¼ | 1.07½ | 1.15 |
| December | 22 | 23½ | 21 | 23 | 18½ | 20½ | 16½ | 18¾ | 17¾ | 21½ | 17¾ | 19 | 19¾ | 21½ | 1.12½ | 1.15 |
| **1897.** | | | | | | | | | | | | | | | | |
| January | 21½ | 22½ | 21 | 22 | 18½ | 20 | 15¾ | 17 | 18 | 19½ | 16¼ | 18¾ | 19¼ | 20 | 1.27½ | 1.30 |
| February | 21 | 21¾ | 21 | 22 | 16¾ | 19½ | 15⅝ | 16½ | 16½ | 19½ | 16¼ | 17¼ | 19¾ | 20 | 1.27½ | 1.30 |
| March | 21½ | 22¼ | 21 | 23½ | 17½ | 21 | 16 | 17 | 17½ | 20¾ | 16½ | 17¼ | 20 | 21½ | 1.20 | 1.30 |
| April | 22 | 23½ | 23½ | 24 | 20 | 21½ | 17 | 18¼ | 18½ | 22½ | 16½ | 19 | 21¼ | 22½ | 1.20 | 1.22½ |
| May | 21½ | 23¼ | 23½ | 26 | 19½ | 22 | 16⅞ | 18¾ | 20 | 23¼ | 18½ | 22 | 22 | 24 | 1.22½ | 1.25 |
| June | 21½ | 23 | 23 | 25½ | 19 | 22 | 17½ | 18½ | 20 | 23 | 20 | 21¼ | 21½ | 23½ | 1.20 | 1.25 |
| July | 21½ | 22½ | 23 | 24 | 19½ | 21½ | 17 | 18⅛ | 20½ | 22½ | 19¾ | 21¼ | 21¼ | 24½ | 1.17½ | 1.22½ |
| August | 21¼ | 22¼ | 20 | 24 | 17 | 21 | 16¼ | 20⅛ | 20 | 23 | 18 | 22½ | 19¾ | 23½ | 1.20 | 1.25 |
| September | 23¼ | 25 | 21 | 23½ | 19½ | 21¾ | 18⅞ | 20¾ | 21 | 23½ | 20⅝ | 23 | 22¾ | 23¼ | 1.27½ | 1.30 |
| October | 22½ | 24½ | 22¾ | 23½ | 20 | 21¾ | 17¾ | 19¾ | 21 | 22¾ | 20¼ | 21½ | 22 | 23¼ | 1.17½ | 1.27½ |
| November | 24½ | 26½ | 23 | 27 | 20½ | 24½ | 19½ | 22¼ | 22¼ | 24½ | 21½ | 22¾ | 22 | 26 | 1.15 | 1.20 |
| December | 26¼ | 29¼ | 26½ | 28 | 23¼ | 25 | 21 | 23⅞ | 23 | 26 | 22 | 25½ | 24½ | 26 | 1.12½ | 1.17½ |
| **1898.** | | | | | | | | | | | | | | | | |
| January | 28¼ | 29¼ | 27½ | 28 | 24 | 26 | 21½ | 24 | 23¾ | 25¼ | 23½ | 25 | 24½ | 26¾ | 1.15 | 1.22½ |
| February | 29 | 32 | 28 | 33 | 25½ | 28¾ | 24 | 27 | 24¾ | 29 | 24 | 28 | 26½ | 32¼ | 1.20 | 1.22½ |
| March | 30 | 32 | 30 | 32½ | 27½ | 29 | 24⅞ | 26¾ | 28 | 30 | 24¾ | 27¼ | 29¾ | 30¾ | 1.20 | 1.32½ |
| April | 29¾ | 35½ | 30 | 35 | 28 | 31 | 25 | 31⅞ | 28 | 33 | 25 | 32¾ | 30¼ | 32½ | 1.32½ | 1.42½ |
| May | 32½ | 36 | 33 | 36 | 29 | 34½ | 26 | 32 | 28¾ | 34½ | 27 | 33¼ | 30¼ | 36¼ | 1.40 | 1.42½ |
| June | 27¾ | 32½ | 27½ | 33 | 25½ | 28 | 21 | 26½ | 25½ | 29½ | 22½ | 28 | 27 | 30¼ | 1.35 | 1.37½ |
| July | 25½ | 28 | 26½ | 32 | 23½ | 27 | 20¾ | 26 | 24 | 29 | 23 | 25 | 26¼ | 29¾ | 1.30 | 1.37½ |
| August | 26¾ | 28½ | 24 | 33 | 21½ | 24¼ | 20¼ | 22½ | 23 | 28¼ | 20 | 24 | 24¼ | 27¼ | 1.20 | 1.32½ |
| September | 25½ | 26¾ | 24 | 26 | 22 | 25 | 20¼ | 22⅝ | 22¼ | 25½ | 21 | 23¾ | 23¼ | 25¾ | 1.17½ | 1.27½ |
| October | 25¾ | 29½ | 25½ | 28 | 23 | 26½ | 21½ | 25 | 24 | 27¾ | 23 | 25½ | 24¾ | 29 | 1.22½ | 1.27½ |
| November | 29 | 30¾ | 27½ | 32 | 26½ | 29 | 24¼ | 27¾ | 27 | 30 | 25 | 27 | 28½ | 29½ | 1.22½ | 1.27½ |
| December | 30⅝ | 33¾ | 31½ | 32½ | 28 | 30 | 26 | 27¾ | 22¾ | 30 | 26¾ | 30 | 29½ | 30¾ | 1.27½ | 1.32½ |

*Wholesale prices of oats per bushel in leading cities of the United States, 1896–1900*—Continued.

| Date. | New York. | | Baltimore. | | Cincinnati. | | Chicago. | | Milwaukee. | | Duluth. | | Detroit. | | San Francisco. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. 2, mixed. | | No. 2, mixed. | | No. 2, mixed. | | No. 2. | | No. 2, white. | | No. 2. | | No. 2, white. | | No. 1, white (per cwt.). | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1899.** | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | | |
| January | 33 | 35 | 32 | 33½ | 28½ | 31 | 26¼ | 27¾ | 28¾ | 31¼ | 28¾ | 30½ | 30½ | 33 | $1.30 | $1.37½ |
| February | 34¼ | 35½ | 33 | 35 | 28¾ | 31½ | 26¾ | 28¼ | 29½ | 31½ | 28¼ | 30 | 32½ | 33 | 1.32 | 1.40 |
| March | 32 | 35¼ | 32 | 34 | 28½ | 31 | 25¼ | 27¾ | 28¾ | 30¾ | 25¾ | 29¼ | 31 | 32¾ | 1.35 | 1.42½ |
| April | 32½ | 33½ | 32 | 33 | 29 | 30½ | 26⅜ | 27¼ | 29½ | 31 | 27¼ | 28 | 32¼ | 33 | 1.37½ | 1.45 |
| May | 31 | 32½ | 29½ | 33 | 27½ | 29½ | 24 | 27¾ | 26¾ | 31 | 26½ | 28 | 30¼ | 32¾ | 1.40 | 1.45 |
| June | 30½ | 31½ | 29½ | 31 | 27 | 29 | 24¼ | 26¼ | 27¼ | 29¼ | 26⅛ | 28½ | 28¾ | 30¼ | 1.37½ | 1.42½ |
| July | 28 | 30½ | 28½ | 31 | 22 | 28½ | 19⅞ | 25 | 24 | 28¾ | 22½ | 26¾ | 25½ | 30 | 1.22½ | 1.27½ |
| August | 26 | 27½ | 24½ | 29 | 21½ | 22½ | 19¼ | 22 | 23 | 25¾ | 19½ | 23¼ | 23½ | 25½ | 1.22½ | 1.27½ |
| September | 25¾ | 29 | 25 | 28 | 22½ | 25½ | 21 | 23¼ | 22¾ | 26 | 20¼ | 24 | 23¾ | 28½ | 1.27½ | 1.30 |
| October | 28½ | 29¼ | 27½ | 29 | 24¾ | 26 | 22 | 23½ | 24¾ | 26 | 22¼ | 24¼ | 26 | 27½ | 1.25 | 1.30 |
| November | 28½ | 30 | 27½ | 29½ | 25¼ | 26½ | 22½ | 24 | 25½ | 26½ | 22½ | 23¾ | 27 | 28 | 1.25 | 1.30 |
| December | 28½ | 30 | 28 | 29½ | 25½ | 26¾ | 22¼ | 23 | 24¾ | 25½ | 22½ | 23¼ | 26½ | 27½ | 1.22½ | 1.27½ |
| **1900.** | | | | | | | | | | | | | | | | |
| January | 29 | 29¾ | 28 | 29½ | 25¼ | 26½ | 22½ | 23 | 25 | 25¾ | 23 | 24 | 26¼ | 28½ | 1.25 | 1.30 |
| February | 29 | 29½ | 28¾ | 29½ | 25¼ | 26 | 22½ | 23¾ | 25½ | 26 | 24 | 24 | 27¼ | 28½ | 1.25 | 1.25 |
| March | 28½ | 29½ | 28 | 29½ | 25¼ | 26½ | 23 | 24½ | 25 | 26¾ | 24 | 24 | 27¼ | 28½ | 1.25 | 1.26¼ |
| April | 27½ | 29½ | 27¾ | 29¼ | 26 | 28 | 23 | 25¼ | 26½ | 29 | 24 | 24½ | 28¼ | 29 | 1.25 | 1.26¼ |
| May | 26 | 28 | 26½ | 28¼ | 24¼ | 26¼ | 21¼ | 23¾ | 24 | 27½ | 23 | 24½ | 27 | 28½ | 1.22½ | 1.25 |
| June | 26 | 29¾ | 26 | 29 | 24 | 27 | 21¾ | 26¼ | 24 | 28½ | 23 | 28 | 26 | 29¼ | 1.22½ | 1.25 |
| July | 26½ | 29 | 27 | 28½ | 25 | 28 | 21½ | 24¾ | 25¾ | 28½ | 23¾ | 28 | 28 | 28½ | 1.25 | 1.30 |
| August | 25½ | 26½ | 24 | 27 | 21 | 25 | 21 | 22⅝ | 24½ | 27 | 23¼ | 24½ | 24½ | 28 | 1.27½ | 1.30 |
| September | 24¾ | 25½ | 24½ | 25¾ | 22¼ | 23½ | 21⅛ | 22¼ | 24¾ | 26 | 22½ | 23¾ | 24¾ | 26 | 1.27½ | 1.27½ |
| October | 25 | 26 | 24¾ | 25½ | 23 | 24 | 21⅜ | 22⅝ | 24¾ | 26 | 23¼ | 24 | 25¼ | 26 | 1.30 | 1.32½ |
| November | 25½ | 26¾ | 24¾ | 26 | 23 | 25 | 21¾ | 22½ | 24¾ | 26¼ | 23¼ | 23¼ | 24 | 26½ | 1.35 | 1.35 |
| December | 26½ | 28½ | 26 | 29 | 24 | 25½ | 21¾ | 22¾ | 25½ | 26¼ | 23½ | 24¾ | 27 | 28 | 1.35 | 1.40 |

*Transportation rates, average for oats in sacks, in cents per 100 pounds, St. Louis to New Orleans by river.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1881 | 20.00 | 1886 | 16.00 | 1891 | 16.28 | 1896 | 14.55 |
| 1882 | 20.00 | 1887 | 18.25 | 1892 | 16.87 | 1897 | 15.00 |
| 1883 | 17.75 | 1888 | 15.00 | 1893 | 17.54 | 1898 | 10.00 |
| 1884 | 14.00 | 1889 | 17.93 | 1894 | 17.14 | 1899 | 10.00 |
| 1885 | 15.00 | 1890 | 15.66 | 1895 | 12.50 | 1900 | 10.00 |

## BARLEY.

The United States produces only a small part of the barley crop of the world. For 1900 the total for this country was only 58,926,000 bushels, out of 921,076,000 bushels for the countries whose crops are reported.

The acreage, as compared with 1899, which was the largest since 1896, shows in 1900 a slight increase, mainly in California, 34,000 acres, and Kansas, 7,000 acres. In Wisconsin the acreage decreased by 10,000 acres and in Iowa by 18,000. Other changes made a total decrease in the United States of 16,000 acres. Upon this smaller seeding there was a decrease in total production of nearly 14,500,000 bushels and in total value of $5,500,000. The average yield per acre fell from 25.5 bushels to 20.4 and the average value from $10.28 to $8.32. The farm price was on an average half a cent better, 40.8 cents in 1900 against 40.3 cents in 1899.

The diminished results just noted were almost wholly consequent upon changes in California, which represents nearly a third of the total acreage and over a fourth of the total production. In that State the yield per acre fell from 26 bushels to 16.7 and the value per acre from $13 to $7.18, the farm price going from 50 to 43 cents. Other States important in barley producing for which decreases were reported are Wisconsin, Minnesota, and the Dakotas. The most important of these was North Dakota, where the yield per acre fell from 24 bushels to 8.2, and in spite of a slight advance in price the total value fell off $1,250,000. In Iowa, the second State in the production of barley, there was a slight advance in the yield per acre, but the total production was 300,000 bushels less. The farm price per bushel in Iowa advanced from 31 to 37 cents and the value per acre from $8.06 to $9.77, giving an increased return to the State.

Wholesale prices of barley on the New York market advanced from 50 cents in January, 1900, to 66 cents in December. Chicago prices for 1900 show wide variations in every month, the narrowest being 36 to 44 in March and May and the widest 36 to 62 in November. San Francisco prices were steady.

The exports of barley in 1900 reached 23,661,662 bushels, worth $11,216,694, the highest figures on record. The export price fell from 60.7 cents per bushel to 47.4 cents.

*Barley crops of the countries named, 1896–1900.*

| Countries. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| United States | 69,695,000 | 66,685,000 | 55,792,000 | 73,382,000 | 58,926,000 |
| Ontario | 13,069,000 | 12,401,000 | 13,063,000 | 15,298,000 | 17,443,000 |
| Manitoba | 3,272,000 | 3,284,000 | 4,413,000 | 5,549,000 | 3,032,000 |
| Rest of Canada | 2,500,000 | 2,400,000 | 2,900,000 | 2,950,000 | 2,500,000 |
| Total Canada | 18,841,000 | 18,085,000 | 20,376,000 | 23,797,000 | 22,975,000 |
| Mexico | 4,079,000 | 8,844,000 | 13,401,000 | 10,000,000 | 10,000,000 |
| Total North America | 92,615,000 | 93,614,000 | 89,569,000 | 107,179,000 | 91,901,000 |
| Great Britain | 73,005,000 | 68,920,000 | 70,197,000 | 69,850,000 | 64,278,000 |
| Ireland | 7,272,000 | 5,982,000 | 6,889,000 | 7,024,000 | 6,422,000 |
| Total United Kingdom | 80,277,000 | 74,902,000 | 77,086,000 | 76,874,000 | 70,700,000 |

*Barley crops of the countries named, 1896–1900*—Continued.

| Countries. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| Sweden | 14,390,000 | 14,303,000 | 14,805,000 | 11,691,000 | 14,786,000 |
| Denmark | 21,249,000 | 19,172,000 | 21,868,000 | 21,694,000 | 21,000,000 |
| Netherlands | 4,561,000 | 3,736,000 | 3,822,000 | 3,600,000 | 3,500,000 |
| Belgium | 3,987,000 | 3,457,000 | 3,695,000 | 3,700,000 | 3,000,000 |
| France | 46,088,000 | 41,157,000 | 46,878,000 | 45,306,000 | 43,612,000 |
| Spain | 32,530,000 | 47,064,000 | 57,668,000 | 53,428,000 | 55,000,000 |
| Italy | 10,057,000 | 7,700,000 | 8,900,000 | 8,000,000 | 7,000,000 |
| Germany | 127,117,000 | 119,580,000 | 132,019,000 | 137,048,000 | 137,889,000 |
| Austria | 54,818,000 | 49,756,000 | 60,044,000 | 68,814,000 | 63,000,000 |
| Hungary | 57,842,000 | 41,290,000 | 54,622,000 | 58,705,000 | 52,000,000 |
| Croatia-Slavonia | 3,021,000 | 2,143,000 | 3,525,000 | 2,785,000 | 3,750,000 |
| Total Austria-Hungary | 115,681,000 | 93,189,000 | 118,191,000 | 130,304,000 | 118,750,000 |
| Roumania | 31,787,000 | 21,225,000 | 29,656,000 | 4,543,000 | 14,575,000 |
| Bulgaria | 20,000,000 | 11,000,000 | 12,204,000 | 6,650,000 | 11,000,000 |
| Russia proper | 208,449,000 | 203,363,000 | 254,702,000 | 179,850,000 | 187,230,000 |
| Poland | 16,744,000 | 15,967,000 | 19,480,000 | 20,090 000 | 18,415,000 |
| North Caucasus | 19,286,000 | 11,120,000 | 25,107,000 | 18,144,000 | 27,105,000 |
| Total Russia in Europe | 244,479,000 | 230,450,000 | 299,289,000 | 218,084,000 | 232,750,000 |
| Total Europe | 752,203,000 | 686,935,000 | 826,081,000 | 720,922,000 | 733,562,000 |
| Siberia | 6,001,000 | 6,119,000 | 4,904,000 | 5,955,000 | 2,969,000 |
| Central Asia | 3,149,000 | 2,081,000 | 2,728,000 | 2,870,000 | 1,262,000 |
| Total Russia in Asia | 9,150,000 | 8,200,000 | 7,632,000 | 8,825,000 | 4,231,000 |
| Japan | 40,180,000 | 41,099,000 | 45,629,000 | 44,000,000 | 44,000,000 |
| Total Asia | 49,330,000 | 49,299,000 | 53,261,000 | 52,825,000 | 48,231,000 |
| Algeria | 31,094,000 | 25,055,000 | 41,467,000 | 33,088,000 | 34,000,000 |
| Tunis | 4,000,000 | 5,000,000 | 11,000,000 | 7,000,000 | 7,000,000 |
| Cape Colony | 690,000 | 793,000 | 937,000 | 857,000 | 800,000 |
| Total Africa | 35,784,000 | 30,848,000 | 53,404,000 | 40,945,000 | 41,800,000 |
| West Australia | 19,000 | 13,000 | 24,000 | 30,000 | 58,000 |
| South Australia | 92,000 | 111,000 | 167,000 | 241,000 | 195,000 |
| Queensland | 8,000 | 20,000 | 52,000 | 36,000 | 122,000 |
| New South Wales | 99,000 | 114,000 | 103,000 | 66,000 | 138,000 |
| Victoria | 738,000 | 841,000 | 782,000 | 1,148,000 | 1,512,000 |
| Tasmania | 143,000 | 77,000 | 72,000 | 190,000 | 70,000 |
| New Zealand | 1,069,000 | 848,000 | 732,000 | 1,731,000 | 1,635,000 |
| Total Australasia | 2,168,000 | 2,024,000 | 1,932,000 | 3,442,000 | 3,730,000 |
| Total | 932,100,000 | 862,720,000 | 1,024,247,000 | 925,313,000 | 919,224,000 |

*Visible supply of barley in the United States the first of each month for ten years.*

| Month. | 1891–1892. | 1892–1893. | 1893–1894. | 1894–1895. | 1895–1896. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| July | 203,100 | 609,607 | 549,000 | 383,000 | 166,000 |
| August | 125,000 | 665,000 | 628,000 | 200,000 | 48,000 |
| September | 138,811 | 580,731 | 464,000 | 774,000 | 121,000 |
| October | 1,633,697 | 1,567,024 | 1,002,000 | 2,401,000 | 1,956,000 |
| November | 3,960,339 | 3,444,387 | 3,242,000 | 4,433,000 | 3,645,000 |
| December | 3,894,964 | 4,103,311 | 4,324,000 | 4,455,000 | 5,674,000 |
| January | 3,320,522 | 3,263,558 | 3,098,000 | 3,781,000 | 4,017,000 |
| February | 2,378,677 | 3,088,000 | 2,495,000 | 2,481,000 | 2,970,000 |
| March | 2,251,035 | 2,476,000 | 1,662,000 | 1,974,000 | 2,081,000 |
| April | 1,458,546 | 1,768,000 | 1,087,000 | 1,274,000 | 1,298,000 |
| May | 833,980 | 1,161,000 | 620,000 | 565,000 | 1,253,000 |
| June | 526,416 | 670,000 | 399,000 | 162,000 | 957,000 |

*Visible supply of barley in the United States the first of each month for ten years*—Continued.

| Month. | 1896–1897. | 1897–1898. | 1898–1899. | 1899–1900. | 1900–1901. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| July | 805,000 | 1,574,000 | 587,000 | 1,059,000 | 1,038,000 |
| August | 771,000 | 1,051,000 | 584,000 | 694,000 | 702,000 |
| September | 790,000 | 1,578,000 | 548,000 | 1,055,000 | 1,158,000 |
| October | 2,292,000 | 2,630,000 | 2,125,000 | 1,739,000 | 2,779,000 |
| November | 6,032,000 | 4,267,000 | 3,777,000 | 3,925,000 | 5,396,000 |
| December | 5,500,000 | 6,318,000 | 4,406,000 | 4,695,000 | 6,053,000 |
| January | 4,501,000 | 5,115,000 | 4,372,000 | 3,122,000 | 5,395,000 |
| February | 4,183,000 | 3,455,000 | 4,017,000 | 2,303,000 | 4,331,000 |
| March | 4,124,000 | 2,571,000 | 3,067,000 | 2,138,000 | 3,903,000 |
| April | 3,514,000 | 1,492,000 | 2,626,000 | 1,712,000 | 2,879,000 |
| May | 2,816,000 | 1,159,000 | 1,913,000 | 1,720,000 | ........ |
| June | 1,819,000 | 815,000 | 1,555,000 | 1,267,000 | ........ |

*Condition of barley crop of United States, monthly, 1885–1900.*

| Year. | June. | July. | August. | September. | Year. | June. | July. | August. | September. |
|---|---|---|---|---|---|---|---|---|---|
| 1885 | ...... | 92.0 | 92.0 | ...... | 1893 | 88.3 | 88.8 | 84.6 | 83.8 |
| 1886 | 100.0 | 89.7 | 90.9 | 92.7 | 1894 | 82.2 | 76.8 | 69.8 | 71.5 |
| 1887 | 87.0 | 82.8 | 86.2 | 83.0 | 1895 | 90.3 | 91.9 | 87.2 | 87.6 |
| 1888 | 88.8 | 91.0 | 89.4 | 86.9 | 1896 | 98.0 | 88.1 | 82.9 | 83.1 |
| 1889 | 95.6 | 91.9 | 90.6 | 88.9 | 1897 | 87.4 | 88.5 | 87.5 | 86.4 |
| 1890 | 86.4 | 88.3 | 82.8 | 78.6 | 1898 | 78.8 | 85.7 | 79.3 | 79.2 |
| 1891 | 90.3 | 90.9 | 93.8 | 94.3 | 1899 | 91.4 | 92.0 | 93.6 | 86.7 |
| 1892 | 92.1 | 92.0 | 91.1 | 87.4 | 1900 | 86.2 | 76.3 | 71.6 | 70.7 |

*Acreage, production, value, prices, exports, and imports of barley of the United States, 1866 to 1900, inclusive.*

| Year. | Acreage. | Average yield per acre. | Production. | Average farm price per bushel, Dec. 1. | Farm value, Dec. 1. | Chicago cash price per bushel, No. 2. | | | | Domestic exports, fiscal years beginning July 1. | Imports, fiscal years beginning July 1. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | December. | | May of following year. | | | |
| | | | | | | Low. | High. | Low. | High. | | |
| | *Acres.* | *Bush.* | *Bushels.* | *Cts.* | *Dollars.* | *Cts.* | *Cts.* | *Cts.* | *Cts.* | *Bushels.* | *Bushels.* |
| 1866 | 492,532 | 22.9 | 11,283,807 | 70.2 | 7,916,342 | 59 | 70 | 85 | 100 | .......... | 3,247,250 |
| 1867 | 1,131,217 | 22.7 | 25,727,000 | 70.1 | 18,027,746 | 150 | 180 | 227 | 250 | 9,810 | 3,783,966 |
| 1868 | 937,498 | 24.4 | 22,896,100 | 109.0 | 24,948,127 | 140 | 170 | 149 | 175 | 59,077 | 5,069,880 |
| 1869 | 1,025,795 | 27.9 | 28,652,200 | 70.8 | 20,298,164 | 74 | 85 | 50 | 62 | 255,490 | 6,727,597 |
| 1870 | 1,108,924 | 23.7 | 26,295,400 | 79.1 | 20,792,213 | 68 | 80 | 72 | 95 | 340,093 | 4,866,700 |
| 1871 | 1,113,735 | 24.0 | 26,718,500 | 75.8 | 20,264,015 | 55½ | 64 | 55 | 71 | 86,891 | 5,565,591 |
| 1872 | 1,397,082 | 19.2 | 26,846,400 | 68.6 | 18,415,839 | 60 | 70 | 71 | 85 | 482,410 | 4,244,751 |
| 1873 | 1,387,106 | 23.1 | 32,044,491 | 86.7 | 27,794,229 | 132 | 158 | 130 | 155 | 320,399 | 4,891,189 |
| 1874 | 1,580,626 | 20.6 | 32,552,500 | 86.0 | 27,997,824 | 120 | 129½ | 115 | 137 | 91,118 | 6,255,063 |
| 1875 | 1,789,902 | 20.6 | 36,908,600 | 74.1 | 27,367,522 | 81 | 88 | 62½ | 72½ | 317,781 | 10,285,957 |
| 1876 | 1,766,511 | 21.9 | 38,710,500 | 63.0 | 24,402,691 | 63¾ | 68½ | 80 | 85 | 1,186,129 | 6,702,965 |
| 1877 | 1,614,654 | 21.3 | 34,441,400 | 62.8 | 21,629,130 | 56¼ | 64 | 46½ | 52½ | 3,921,501 | 6,764,228 |
| 1878 | 1,790,400 | 23.6 | 42,245,630 | 57.9 | 24,454,301 | 91 | 100 | 64 | 73 | 715,536 | 5,720,979 |
| 1879 | 1,680,700 | 24.0 | 40,283,100 | 58.9 | 23,714,444 | 86 | 92 | 75 | 80 | 1,128,923 | 7,135,258 |
| 1880 | 1,843,329 | 24.5 | 45,165,346 | 66.6 | 30,090,742 | 100 | 120 | 95 | 105 | 885,246 | 9,528,616 |
| 1881 | 1,967,510 | 20.9 | 41,161,330 | 82.3 | 33,862,513 | 101 | 107 | 100 | 100 | 205,930 | 12,182,722 |
| 1882 | 2,272,103 | 21.5 | 48,953,926 | 62.9 | 30,768,015 | 79 | 82 | 80 | 80 | 433,005 | 10,050,687 |
| 1883 | 2,379,009 | 21.1 | 50,136,097 | 58.7 | 29,420,423 | 62 | 67 | 65 | 74 | 724,955 | 8,596,122 |
| 1884 | 2,608,818 | 23.5 | 61,203,000 | 48.7 | 29,779,170 | 53 | 58 | 65 | 65 | 629,130 | 9,986,507 |
| 1885 | 2,729,359 | 21.4 | 58,360,000 | 56.3 | 32,867,696 | 62 | 65 | 58 | 60 | 252,183 | 10,197,115 |
| 1886 | 2,652,957 | 22.4 | 59,428,000 | 53.6 | 31,840,510 | 51 | 54 | 57 | 57 | 1,305,300 | 10,355,594 |
| 1887 | 2,901,953 | 19.6 | 56,812,000 | 51.9 | 29,464,390 | 80 | 80 | 69 | 77 | 550,884 | 10,831,461 |
| 1888 | 2,996,382 | 21.3 | 63,884,000 | 59.0 | 37,672,032 | ...... | ...... | ...... | ...... | 1,440,321 | 11,368,414 |
| 1889 | 3,220,834 | 24.3 | 78,332,976 | 41.6 | 32,614,271 | 58 | 58 | ...... | ...... | 1,408,311 | 11,332,545 |
| 1890 | 3,135,302 | 21.4 | 67,168,344 | 62.7 | 42,140,502 | ...... | ...... | ...... | ...... | 973,062 | 5,078,733 |
| 1891 | 3,352,579 | 25.9 | 86,839,153 | 52.4 | 45,470,342 | ...... | ...... | ...... | ...... | 2,800,075 | 3,146,328 |
| 1892 | 3,400,361 | 23.6 | 80,096,762 | 47.5 | 38,026,062 | 65 | 67 | 65 | 65 | 3,035,267 | 1,970,129 |
| 1893 | 3,220,371 | 21.7 | 69,869,495 | 41.1 | 28,729,386 | 52 | 54 | 55 | 60 | 5,219,405 | 791,061 |
| 1894 | 3,170,602 | 19.4 | 61,400,465 | 44.2 | 27,134,127 | 53½ | 55½ | 51 | 52 | 1,563,754 | 2,116,816 |
| 1895 | 3,299,973 | 26.4 | 87,072,744 | 33.7 | 29,312,413 | 33 | 40 | 25 | 36 | 7,680,331 | 837,384 |
| 1896 | 2,950,539 | 23.6 | 69,695,223 | 32.3 | 22,491,241 | [1] 22 | 37 | [1] 24½ | 35 | 20,030,301 | 1,271,787 |
| 1897 | 2,719,116 | 24.5 | 66,685,127 | 37.7 | 25,142,139 | [1] 25½ | 42 | [1] 36 | 53 | 11,237,077 | 124,804 |
| 1898 | 2,583,125 | 21.6 | 55,792,257 | 41.3 | 23,064,359 | [1] 40 | 50½ | [1] 36 | 42 | 2,267,400 | 110,475 |
| 1899 | 2,878,229 | 25.5 | 73,381,563 | 40.3 | 29,594,254 | [1] 35 | 45 | [1] 36 | 44 | 23,661,662 | 189,757 |
| 1900 | 2,894,282 | 20.4 | 58,925,833 | 40.8 | 24,075,271 | [1] 37 | 61 | ...... | ...... | .......... | .......... |

[1] Chicago prices from 1895 are for No. 3 grade.

*Acreage, production, and value of barley in the United States in 1900, by States.*

| States and Territories. | Acreage. | Average yield per acre. | Production. | Average farm price, Dec. 1. | Average value per acre. | Farm value, Dec. 1. |
|---|---|---|---|---|---|---|
| | *Acres.* | *Bushels.* | *Bushels.* | *Cents.* | *Dollars.* | *Dollars.* |
| Maine | 11,508 | 27.4 | 315,319 | 62 | 16.99 | 195,498 |
| New Hampshire | 4,528 | 22.7 | 102,786 | 67 | 15.21 | 68,867 |
| Vermont | 17,210 | 29.1 | 500,811 | 52 | 15.13 | 260,422 |
| Massachusetts | 1,661 | 25.8 | 42,854 | 69 | 17.80 | 29,569 |
| Rhode Island | 312 | 28.0 | 8,736 | 77 | 21.56 | 6,727 |
| New York | 170,542 | 22.0 | 3,751,924 | 51 | 11.22 | 1,913,481 |
| Pennsylvania | 7,793 | 19.0 | 148,067 | 50 | 9.50 | 74,034 |
| Texas | 2,049 | 24.6 | 50,405 | 72 | 17.71 | 36,292 |
| Tennessee | 1,743 | 14.7 | 25,622 | 62 | 9.11 | 15,886 |
| Kentucky | 1,312 | 28.6 | 37,523 | 55 | 15.73 | 20,638 |
| Ohio | 23,058 | 27.0 | 622,566 | 43 | 11.61 | 267,703 |
| Michigan | 37,858 | 23.9 | 904,806 | 47 | 11.23 | 425,259 |
| Indiana | 7,542 | 24.6 | 185,533 | 47 | 11.56 | 87,201 |
| Illinois | 13,365 | 25.6 | 342,144 | 47 | 12.03 | 160,808 |
| Wisconsin | 245,458 | 25.5 | 6,259,179 | 44 | 11.22 | 2,754,039 |
| Minnesota | 324,788 | 22.4 | 7,275,251 | 38 | 8.51 | 2,764,595 |
| Iowa | 443,516 | 26.4 | 11,708,822 | 37 | 9.77 | 4,332,264 |
| Missouri | 713 | 20.8 | 14,830 | 45 | 9.36 | 6,674 |
| Kansas | 194,735 | 21.5 | 4,186,802 | 33 | 7.10 | 1,381,645 |
| Nebraska | 33,374 | 17.6 | 587,382 | 33 | 5.81 | 193,836 |
| South Dakota | 107,942 | 14.3 | 1,543,571 | 31 | 4.43 | 478,507 |
| North Dakota | 243,761 | 8.2 | 1,998,840 | 35 | 2.87 | 699,594 |
| Montana | 5,194 | 38.8 | 201,527 | 48 | 18.62 | 96,733 |
| Colorado | 12,672 | 24.8 | 314,266 | 50 | 12.40 | 157,133 |
| New Mexico | 1,076 | 29.0 | 31,204 | 62 | 17.98 | 19,346 |
| Utah | 5,964 | 36.5 | 217,686 | 55 | 20.07 | 119,727 |
| Idaho | 12,165 | 32.8 | 399,012 | 50 | 16.40 | 199,506 |
| Washington | 41,505 | 33.4 | 1,386,267 | 39 | 13.03 | 540,644 |
| Oregon | 31,347 | 28.9 | 905,928 | 42 | 12.14 | 380,490 |
| California | 889,591 | 16.7 | 14,856,170 | 43 | 7.18 | 6,388,153 |
| United States | 2,894,282 | 20.4 | 58,925,833 | 40.8 | 8.32 | 24,075,271 |

*Average yield per acre of barley in the United States, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* |
| Maine | 26.5 | 22.3 | 26.1 | 26.1 | 32.4 | 30.6 | 25.0 | 27.0 | 29.0 | 27.4 |
| New Hampshire | 26.3 | 23.5 | 25.3 | 24.4 | 25.6 | 29.3 | 22.5 | 23.5 | 25.0 | 22.7 |
| Vermont | 27.3 | 26.0 | 27.5 | 27.9 | 33.2 | 33.0 | 28.5 | 30.0 | 31.0 | 29.1 |
| Massachusetts | 26.7 | 22.5 | 25.3 | 21.7 | 22.5 | 30.0 | 34.5 | 24.5 | 30.0 | 25.8 |
| Rhode Island | 28.0 | 21.5 | 25.2 | 30.0 | 23.5 | 29.0 | 28.0 | 28.0 | 29.0 | 28.0 |
| New York | 23.3 | 22.2 | 20.3 | 17.5 | 22.9 | 23.2 | 25.0 | 25.2 | 24.0 | 22.0 |
| Pennsylvania | 22.5 | 21.7 | 19.0 | 16.6 | 20.2 | 17.2 | 24.5 | 19.4 | 21.0 | 19.0 |
| Texas | 15.2 | 16.5 | 14.5 | 15.3 | 21.6 | 12.0 | 25.0 | 20.0 | 18.0 | 24.6 |
| Tennessee | 12.7 | 19.5 | 15.1 | 13.8 | 23.1 | 14.0 | 18.0 | 18.0 | 11.0 | 14.7 |
| Kentucky | 24.5 | 22.3 | 17.0 | 28.7 | 33.3 | 14.8 | 20.0 | 16.0 | 21.0 | 28.6 |
| Ohio | 25.7 | 23.5 | 22.7 | 28.5 | 28.2 | 20.2 | 28.5 | 28.7 | 28.0 | 27.0 |
| Michigan | 24.5 | 23 4 | 16.4 | 20.6 | 18.1 | 22.3 | 21.5 | 25.2 | 24.0 | 23.9 |
| Indiana | 23.5 | 28.0 | 19.9 | 20.7 | 15.0 | 20.3 | 19.0 | 23.4 | 25.0 | 24.6 |
| Illinois | 26.0 | 17.9 | 23.2 | 23.5 | 20.0 | 23.7 | 25.0 | 27.3 | 29.0 | 25.6 |
| Wisconsin | 26.5 | 25.5 | 24.0 | 28.6 | 29.3 | 27.4 | 28.0 | 29.1 | 30.0 | 25.5 |
| Minnesota | 27.3 | 24.9 | 22.1 | 23.5 | 36.0 | 27.2 | 25.5 | 28.4 | 25.0 | 22.4 |
| Iowa | 27.3 | 21.1 | 22.6 | 15.5 | 28.0 | 26.3 | 24.0 | 26.0 | 26.0 | 26.4 |
| Missouri | ...... | 29.1 | 20.0 | 14.0 | 15.3 | 17.5 | 19.0 | 20.0 | 18.0 | 20.8 |
| Kansas | 26.5 | 25.0 | 8.1 | 8.8 | 14.4 | 4.6 | 17.5 | 28.0 | 17.0 | 21.5 |
| Nebraska | 27.2 | 22.2 | 12.0 | 5.7 | 28.4 | 19.9 | 22.0 | 27.1 | 26.0 | 17.6 |
| South Dakota | 28.5 | 23.3 | 15.4 | 14.7 | 19.5 | 28.5 | 20.0 | 23.0 | 23.0 | 14.3 |
| North Dakota | 30.0 | 24.3 | 15.2 | 20.1 | 30.4 | 16.1 | 22.5 | 26.4 | 24.0 | 8.2 |
| Montana | 30.0 | 32.5 | 30.1 | 22.5 | 25.0 | 25.0 | 38.0 | 36.0 | 35.0 | 38.8 |
| Colorado | 26.5 | 24.0 | 28.3 | 27.8 | 31.3 | 20.0 | 28.0 | 30.5 | 28.0 | 24.8 |
| New Mexico | 22.0 | 19.6 | 21.6 | 27.0 | 28.0 | 19.0 | 32.5 | 33.8 | 32.0 | 29.0 |
| Utah | 26.7 | 20.3 | 37 6 | 33.0 | 30.0 | 27.1 | 31.0 | 37.0 | 33.0 | 36.5 |
| Idaho | 29.0 | 26.0 | 30.0 | 32.6 | 24.5 | 15.3 | 35.0 | 35.0 | 35.0 | 32.8 |
| Washington | 31.5 | 25.3 | 40.1 | 33.7 | 37.3 | 26.0 | 45.0 | 39.8 | 35.0 | 33.4 |
| Oregon | 24.0 | 23.3 | 26.1 | 38.6 | 22.1 | 21.8 | 32.5 | 29.1 | 28.0 | 28.9 |
| California | 23.7 | 24.0 | 22.5 | 15.2 | 20.3 | 21.6 | 23.0 | 10.5 | 26.0 | 16.7 |
| General average | 25.80 | 23.70 | 21.70 | 19.37 | 26.39 | 23.62 | 24.52 | 21.60 | 25.50 | 20.4 |

*Average yield of barley in certain countries, in bushels, per acre, 1894–1899.*

| Year. | United States. | Russia. | Germany. | Austria. | Hungary. | France. | United Kingdom. |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (2) | (1) | (1) | (1) | (1) |
| 1894 | 19.4 | 15.3 | 33.0 | 21.6 | 21.2 | 22.0 | 35.9 |
| 1895 | 26.4 | 13.7 | 31.2 | 20.0 | 20.6 | 21.9 | 33.1 |
| 1896 | 23.6 | 12.8 | 30.7 | 18.8 | 22.8 | 21.8 | 35.2 |
| 1897 | 24.5 | 11.8 | 29.0 | 17.1 | 17.3 | 19.4 | 33.9 |
| 1898 | 21.6 | 14.9 | 32.2 | 20.8 | 22.5 | 23.3 | 37.4 |
| 1899 | 25.5 | 11.1 | 33.8 | 23.4 | 22.9 | 22.7 | 35.7 |
| Average | 23.5 | 13.3 | 31.6 | 20.3 | 21.2 | 21.8 | 35.2 |

[1] Winchester bushels. [2] Bushels of 48 pounds.

*Average value per acre of barley in the United States, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| Maine | $19.08 | $15.16 | $17.49 | $17.23 | $16.85 | $13.16 | $13.75 | $15.12 | $17.11 | **$16.99** |
| New Hampshire | 19.46 | 17.39 | 17.71 | 15.37 | 14.34 | 15.53 | 13.50 | 13.63 | 16.25 | **15.21** |
| Vermont | 19.66 | 17.16 | 16.50 | 16.74 | 15.60 | 13.53 | 13.11 | 14.10 | 16.12 | **15.13** |
| Massachusetts | 20.03 | 16.87 | 22.77 | 13.67 | 14.63 | 17.40 | 22.77 | 16.17 | 20.40 | **17.80** |
| Rhode Island | 21.84 | 17.63 | 21.92 | 21.60 | 17.63 | 17.40 | 15.12 | 17.08 | 20.30 | **21.56** |
| New York | 15.15 | 16.65 | 12.18 | 9.80 | 18.55 | 9.05 | 10.50 | 12.10 | 12.00 | **11.22** |
| Pennsylvania | 14.40 | 12.37 | 9.50 | 7.97 | 8.28 | 6.88 | 9.55 | 8.54 | 10.29 | **9.50** |
| Texas | 11.86 | 10.73 | 8.99 | 8.41 | 11.66 | 6.00 | 10.75 | 10.00 | 11.88 | **17.71** |
| Tennessee | 6.86 | 12.87 | 8.31 | 7.73 | 11.55 | 6.30 | 10.62 | 10.08 | 7.04 | **9.11** |
| Kentucky | 13.23 | 8.47 | 8.67 | 13.49 | 12.65 | 5.92 | 8.00 | 6.40 | 9.03 | **15.73** |
| Ohio | 15.42 | 13.39 | 10.67 | 13.68 | 11.56 | 7.68 | 11.69 | 12.63 | 12.60 | **11.61** |
| Michigan | 14.70 | 14.04 | 8.04 | 10.30 | 7.78 | 9.37 | 8.60 | 11.09 | 11.52 | **11.23** |
| Indiana | 13.87 | 14.56 | 8.95 | 9.32 | 6.00 | 6.70 | 8.36 | 10.30 | 11.25 | **11.56** |
| Illinois | 14.30 | 8.77 | 9.28 | 11.28 | 9.00 | 7.35 | 9.50 | 10.65 | 13.63 | **12.03** |
| Wisconsin | 14.57 | 12.75 | 10.32 | 12.87 | 9.96 | 7.40 | 8.96 | 11.64 | 12.00 | **11.22** |
| Minnesota | 11.74 | 12.31 | 7.96 | 9.63 | 8.64 | 5.44 | 6.12 | 9.37 | 7.75 | **8.51** |
| Iowa | 11.47 | 8.44 | 7.46 | 6.51 | 6.44 | 5.52 | 5.76 | 8.84 | 8.06 | **9.77** |
| Missouri | 14.71 | 12.22 | 8.00 | 7.14 | 7.34 | 4.38 | 7.60 | 7.20 | 7.56 | **9.36** |
| Kansas | 10.60 | 8.75 | 3.81 | 4.31 | 3.31 | 1.01 | 4.38 | 7.56 | 4.59 | **7.10** |
| Nebraska | 10.06 | 7.33 | 3.72 | 2.45 | 6.82 | 3.78 | 5.28 | 6.78 | 7.80 | **5.81** |
| South Dakota | 11.68 | 8.16 | 5.08 | 4.72 | 3.71 | 5.42 | 4.40 | 6.21 | 6.67 | **4.43** |
| North Dakota | 12.60 | 8.02 | 4.71 | 7.24 | 6.08 | 3.38 | 6.07 | 7.66 | 7.92 | **2.87** |
| Montana | 19.50 | 21.45 | 15.05 | 9.00 | 14.75 | 13.75 | 19.00 | 20.52 | 17.85 | **18.62** |
| Colorado | 14.84 | 12.96 | 14.15 | 16.04 | 18.78 | 9.20 | 14.28 | 14.03 | 15.40 | **12.40** |
| New Mexico | 15.40 | 12.74 | 12.53 | 18.90 | 19.04 | 12.35 | 17.88 | 18.59 | 19.52 | **17.98** |
| Utah | 16.02 | 10.56 | 16.92 | 15.18 | 11.70 | 11.38 | 13.95 | 17.39 | 17.16 | **20.07** |
| Idaho | 19.72 | 8.58 | 15.90 | 15.32 | 10.29 | 3.37 | 14.70 | 16.80 | 16.10 | **16.40** |
| Washington | 18.90 | 11.39 | 15.64 | 10.78 | 14.17 | 10.40 | 19.35 | 17.91 | 15.40 | **13.03** |
| Oregon | 11.52 | 10.72 | 10.44 | 12.74 | 8.84 | 9.81 | 14.63 | 14.26 | 14.00 | **12.14** |
| California | 14.46 | 11.28 | 9.45 | 6.84 | 8.12 | 10.37 | 12.42 | 6.82 | 13.00 | **7.18** |
| General average | 13.56 | 11.18 | 8.92 | 8.56 | 8.88 | 7.62 | 9.25 | 8.93 | 10.28 | **8.32** |

*Average farm price per bushel of barley in the United States December 1, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | ***Cents.*** |
| Maine | 72 | 68 | 67 | 66 | 52 | 43 | 55 | 56 | 59 | **62** |
| New Hampshire | 74 | 74 | 70 | 63 | 56 | 53 | 60 | 58 | 65 | **67** |
| Vermont | 72 | 66 | 60 | 60 | 47 | 41 | 46 | 47 | 52 | **52** |
| Massachusetts | 75 | 75 | 90 | 63 | 65 | 58 | 66 | 66 | 68 | **69** |
| Rhode Island | 78 | 82 | 87 | 72 | 75 | 60 | 54 | 61 | 70 | **77** |
| New York | 65 | 75 | 60 | 56 | 81 | 39 | 42 | 48 | 50 | **51** |
| Pennsylvania | 64 | 57 | 50 | 48 | 41 | 40 | 39 | 44 | 49 | **50** |
| Texas | 78 | 65 | 62 | 55 | 54 | 50 | 43 | 50 | 66 | **72** |
| Tennessee | ...... | 66 | 55 | 56 | 50 | 45 | 59 | 56 | 64 | **62** |
| Kentucky | ...... | 38 | 51 | 47 | 38 | 40 | 40 | 40 | 43 | **55** |
| Ohio | 60 | 57 | 47 | 48 | 41 | 38 | 41 | 44 | 45 | **43** |
| Michigan | 60 | 60 | 49 | 50 | 43 | 42 | 40 | 44 | 48 | **47** |
| Indiana | 59 | 52 | 45 | 45 | 40 | 33 | 44 | 44 | 45 | **47** |
| Illinois | 55 | 49 | 40 | 48 | 45 | 31 | 38 | 39 | 47 | **47** |
| Wisconsin | 55 | 50 | 43 | 45 | 34 | 27 | 32 | 40 | 40 | **44** |
| Minnesota | 43 | 42 | 36 | 41 | 24 | 20 | 24 | 33 | 31 | **38** |
| Iowa | 42 | 40 | 33 | 42 | 23 | 21 | 24 | 34 | 31 | **37** |
| Missouri | 57 | 42 | 40 | 51 | 48 | 25 | 40 | 36 | 42 | **45** |
| Kansas | 40 | 35 | 47 | 49 | 23 | 22 | 25 | 27 | 27 | **33** |

*Average farm price per bushel of barley in the United States December 1, 1891–1900, by States*—Continued.

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| Nebraska | 37 | 33 | 31 | 43 | 24 | 19 | 24 | 25 | 30 | 33 |
| South Dakota | 41 | 35 | 33 | 35 | 19 | 19 | 22 | 27 | 29 | 31 |
| North Dakota | 42 | 33 | 31 | 36 | 20 | 21 | 27 | 29 | 33 | 35 |
| Montana | 65 | 66 | 50 | 40 | 59 | 55 | 50 | 57 | 51 | 48 |
| Colorado | 56 | 54 | 50 | 58 | 60 | 46 | 51 | 46 | 55 | 50 |
| New Mexico | 70 | 65 | 58 | 70 | 68 | 65 | 55 | 55 | 61 | 62 |
| Utah | 60 | 52 | 45 | 46 | 39 | 42 | 45 | 47 | 52 | 55 |
| Idaho | 68 | 33 | 53 | 47 | 42 | 22 | 42 | 48 | 46 | 50 |
| Washington | 60 | 45 | 39 | 32 | 38 | 40 | 43 | 45 | 44 | 39 |
| Oregon | 48 | 46 | 40 | 33 | 40 | 45 | 45 | 49 | 50 | 42 |
| California | 61 | 47 | 42 | 45 | 40 | 48 | 54 | 65 | 50 | 43 |
| General average | 54.00 | 47.20 | 41.12 | 44.19 | 33.66 | 32.27 | 37.70 | 41.34 | 40.33 | 40.8 |

*Transportation rates, average for barley in sacks, in cents per 100 pounds, St. Louis to New Orleans by river.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1881 | 20.00 | 1886 | 16.00 | 1891 | 16.28 | 1896 | 14.55 |
| 1882 | 20.00 | 1887 | 18.25 | 1892 | 16.87 | 1897 | 15.00 |
| 1883 | 17.75 | 1888 | 15.00 | 1893 | 17.54 | 1898 | 10.00 |
| 1884 | 14.00 | 1889 | 17.93 | 1894 | 17.14 | 1899 | 10.00 |
| 1885 | 15.00 | 1890 | 15.66 | 1895 | 12.50 | 1900 | 10.00 |

*Wholesale prices of barley per bushel in leading cities of the United States, 1896–1900.*

| Date. | New York. | | Cincinnati. | | Chicago. | | San Francisco. | |
|---|---|---|---|---|---|---|---|---|
| | Western. | | No. 2, fall. | | No. 3. | | No. 1, brewing, per cwt. | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | | | | | | | | |
| January | $0.38 | $0.47 | ........ | ........ | $0.23 | $0.40 | $0.80 | $0.80 |
| February | .38 | .48 | ........ | ........ | .26 | .38 | .80 | .80 |
| March | .37 | .48 | ........ | ........ | .24 | .38 | .82½ | .82½ |
| April | .35 | .45 | ........ | ........ | .25 | .38 | .82½ | .85 |
| May | .35 | .41 | ........ | ........ | .25 | .36 | .80 | .85 |
| June | .25 | .41 | ........ | ........ | .23 | .34 | .80 | .80 |
| July | .25 | .33 | ........ | ........ | ........ | ........ | .77½ | .80 |
| August | .27 | .33½ | ........ | ........ | ........ | ........ | .77½ | .77½ |
| September | .30 | .32½ | ........ | ........ | .20 | .35 | .76¼ | .77½ |
| October | .30 | .36 | ........ | ........ | .23½ | .37 | .80 | .90 |
| November | .30 | .32¾ | $0.36 | $0.36 | .23 | .38 | .90 | .95 |
| December | .31 | .33½ | .35 | .36 | .22 | .37 | .95 | .95 |
| **1897.** | | | | | | | | |
| January | .33½ | .35½ | .35 | .36 | .23½ | .35 | .95 | 1.00 |
| February | .31¼ | .33¾ | .35 | .36 | .22½ | .35 | .90 | .92½ |
| March | .31 | .33 | .35 | .36 | .22½ | .33 | .82½ | .92½ |
| April | .31 | .33 | .35 | .36 | .22 | .34 | .82½ | .87½ |
| May | .31 | .32½ | .35 | .36 | .24½ | .35 | .85 | .87½ |
| June | .30 | .32 | .35 | .36 | .26 | .34 | .85 | .90 |
| July | .31¾ | .33½ | .35 | .36 | .25½ | .34 | .87½ | 1.00 |
| August | .34½ | .47 | .35 | .36 | .25 | .46 | 1.02½ | 1.12½ |
| September | .39 | .47 | .35 | .46 | .26 | .47 | 1.07½ | 1.10 |
| October | .50 | .53 | .45 | .46 | .25 | .43 | 1.02½ | 1.10 |
| November | .42½ | .49 | .45 | .46 | .25½ | .45 | 1.02½ | 1.07½ |
| December | .43½ | .49 | .45 | .46 | .25½ | .42 | 1.02½ | 1.05 |
| **1898.** | | | | | | | | |
| January | .50 | .52 | .45 | .46 | .26½ | .42 | .92½ | .97½ |
| February | .52 | .53 | .45 | .46 | .27½ | .42 | .97½ | 1.07½ |
| March | .52 | .54 | .45 | .46 | .32 | .43 | 1.07½ | 1.20 |
| April | .54 | .55 | .45 | .46 | .34 | .52 | 1.22½ | 1.42½ |
| May | .55 | .61 | .45 | .57 | .36 | .53 | 1.25 | 1.35 |
| June | .48 | .60 | ........ | ........ | .30 | .46 | 1.15 | 1.22½ |
| July | .46 | .48 | ........ | ........ | .30 | .38 | 1.17½ | 1.22½ |
| August | .46 | .48 | ........ | ........ | .30 | .47½ | 1.15 | 1.20 |
| September | .46 | .48 | ........ | ........ | .32½ | .45 | 1.15 | 1.22½ |
| October | .48 | .50 | ........ | ........ | .32 | .49 | 1.20 | 1.22½ |
| November | .52 | .56 | ........ | ........ | .36 | .50 | 1.20 | 1.27½ |
| December | .57 | .60 | ........ | ........ | .40 | .50½ | 1.22½ | 1.30 |

*Wholesale prices of barley per bushel in leading cities of the United States, 1896–1900*—Continued.

| Date. | New York. | | Cincinnati. | | Chicago. | | San Francisco. | |
|---|---|---|---|---|---|---|---|---|
| | Western. | | No. 2, fall. | | No. 3. | | No. 1, brewing, per cwt. | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1899.** | | | Extra No. 3, spring. | | | | | |
| January | \$0.57 | \$0.62 | \$0.50 | \$0.56 | \$0.41 | \$0.54 | \$1.40 | \$1.47½ |
| February | .60 | .62 | .50 | .56 | .41 | .53 | 1.40 | 1.42½ |
| March | .53 | .60 | .50 | .53 | .38 | .51 | 1.35 | 1.42½ |
| April | .54 | .55 | .50 | .53 | .39 | .48 | 1.20 | 1.37½ |
| May | .50 | .54 | .50 | .53 | .36 | .42 | 1.17½ | 1.25 |
| June | .46 | .52 | ........ | ........ | .35½ | .42 | 1.02½ | 1.22½ |
| July | .48 | .50 | ........ | ........ | .34 | .42 | 1.05 | 1.15 |
| August | .43 | .50 | ........ | ........ | .34 | .43 | .97½ | 1.05 |
| September | .50 | .52 | .44 | .50 | .36 | .47 | .95 | 1.01¼ |
| October | .50 | .54 | .50 | .50 | .37 | .46 | 1.00 | 1.03¾ |
| November | .46 | .50 | .48 | .50 | .34 | .45 | .96¼ | 1.01¼ |
| December | .49 | .52 | .45 | .50 | .35 | .45 | .85 | .97½ |
| **1900.** | | | | | | | | |
| January | .49 | .50 | ........ | ........ | .34 | .48 | .72½ | .75 |
| February | .50 | .51 | ........ | ........ | .34 | .46 | .72½ | .75 |
| March | .52 | .50 | ........ | ........ | .36 | .44 | .72½ | .73¾ |
| April | .52 | .52½ | ........ | ........ | .36 | .45 | .72½ | .72½ |
| May | .52 | .52 | ........ | ........ | .36 | .44 | .67½ | .72½ |
| June | .51 | .55 | ........ | ........ | .36 | .43 | .67½ | .70 |
| July | .54 | .54 | ........ | ........ | .36 | .48 | .70 | .71¼ |
| August | .52 | .57 | ........ | ........ | .33 | .50 | .72½ | .72½ |
| September | .54 | .58 | ........ | ........ | .38 | .57 | .72½ | .72½ |
| October | .60 | .62 | ........ | ........ | .36 | .59 | .71¼ | .72½ |
| November | .62 | .65 | ........ | ........ | .36 | .62 | .72½ | .75 |
| December | .64 | .66 | ........ | ........ | .37 | .61 | .72½ | .75 |

## RYE.

The rye crops of the world in 1899 and 1900 were notably larger than in any of the preceding years, and wholesale prices on the leading markets made a steady decline. In January, 1899, rye was worth 53½ to 58¾ cents in Chicago, in January, 1900, from 50 to 52 cents, and in December, 1900, it was worth 45¾ to 49¾ cents. In late years exports of rye and rye flour from the United States have been of considerable importance, reaching nearly \$9,000,000 in 1898 and nearly \$6,000,000 in 1899; but in 1900 there was a great falling off, the value being only \$1,442,055. The export price advanced from 58.5 cents a bushel to 61.2 cents.

The rye crop of this country, however, was only 23,996,000 bushels in a world's crop of 1,605,226,000 bushels in 1900, and the ratio shows very little change as compared with previous years. The total acreage decreased 68,000 acres, but the average yield increased from 14.4 to 15.1 bushels per acre and the farm price gained one-tenth of 1 cent, giving \$12,295,417 as the total worth of the crop, against \$12,214,118 in 1899.

New York, Pennsylvania, and Wisconsin are in the first class as rye States, with Kansas, Iowa, Minnesota, Illinois, Michigan, and New Jersey in the second rank. Of these States only Pennsylvania had an increased acreage, but in every case except New York the yield per acre advanced, and this, with a stationary or increased farm price, except in Michigan, brought up the average value per acre. Notable increases in yield were from 11 to 15.2 bushels per acre in Kansas, 15 to 17.2 in Illinois, and 18 to 19.5 in Minnesota. The leading advances in value per acre were in Kansas, from \$4.62 to \$6.54, and in Illinois, from \$7.05 to \$8.08. In New York the yield per acre fell from 16 bushels to 15.1, and the value from \$8.96 to \$8.46.

In Michigan, while there was a slight increase in yield, the farm price dropped from 52 cents to 48, and the value per acre from \$7.28 to \$7.01.

*Rye crops of the countries named, 1896–1900.*

| Countries. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| United States | 24,369,000 | 27,363,000 | 25,658,000 | 23,962,000 | 23,996,000 |
| Ontario | 2,301,000 | 3,489,000 | 2,757,000 | 2,357,000 | 2,432,000 |
| Manitoba | 54,000 | 50,000 | 66,000 | 66,000 | 27,000 |
| Rest of Canada | 400,000 | 470,000 | 420,000 | 400,000 | 375,000 |
| Total Canada | 2,755,000 | 4,009,000 | 3,243,000 | 2,823,000 | 2,834,000 |
| Total North America | 27,124,000 | 31,372,000 | 28,901,000 | 26,785,000 | 26,830,000 |
| Great Britain | 2,065,000 | 1,709,000 | 1,782,000 | | |
| Ireland | 349,000 | 283,000 | 316,000 | | |
| Total United Kingdom | 2,414,000 | 1,992,000 | 2,098,000 | 2,000,000 | 2,000,000 |
| Sweden | 24,026,000 | 23,599,000 | 21,469,000 | 21,436,000 | 26,008,000 |
| Denmark | 20,081,000 | 18,116,000 | 16,132,000 | 18,359,000 | 18,000,000 |
| Netherlands | 13,571,000 | 11,930,000 | 13,664,000 | 11,500,000 | 12,000,000 |
| Belgium | 22,218,000 | 20,401,000 | 20,707,000 | 16,000,000 | 19,000,000 |
| France | 69,424,000 | 48,139,000 | 66,755,000 | 66,904,000 | 63,546,000 |
| Spain | 15,381,000 | 18,672,000 | 19,324,000 | 20,519,000 | 19,000,000 |
| Italy | 4,000,000 | 4,000,000 | 4,000,000 | 2,700,000 | 3,200,000 |
| Germany | 335,970,000 | 321,659,000 | 355,581,000 | 341,551,000 | 336,624,000 |
| Austria | 76,696,000 | 65,828,000 | 81,620,000 | 87,676,000 | 65,000,000 |
| Hungary | 48,426,000 | 35,309,000 | 43,142,000 | 47,482,000 | 40,000,000 |
| Croatia-Slavonia | 3,021,000 | 2,369,000 | 3,586,000 | 2,781,000 | 2,500,000 |
| Total Austria-Hungary | 128,143,000 | 103,506,000 | 128,348,000 | 137,939,000 | 107,500,000 |
| Roumania | 12,217,000 | 6,794,000 | 7,629,000 | 1,988,000 | 5,987,000 |
| Bulgaria | 4,800,000 | 10,000,000 | 5,437,000 | 4,655,000 | 7,000,000 |
| Russia proper | 700,983,000 | 567,466,000 | 636,467,000 | 805,230,000 | 828,816,000 |
| Poland | 61,845,000 | 54,228,000 | 72,029,000 | 67,580,000 | 67,621,000 |
| North Caucasus | 4,584,000 | 3,758,000 | 5,572,000 | 7,638,000 | 7,500,000 |
| Total Russia in Europe | 767,412,000 | 625,452,000 | 714,068,000 | 880,448,000 | 903,931,000 |
| Total Europe | 1,419,657,000 | 1,214,260,000 | 1,375,212,000 | 1,525,999,000 | 1,523,802,000 |
| Siberia | 21,154,000 | 27,994,000 | 22,627,000 | 30,523,000 | 15,853,000 |
| Central Asia | 994,000 | 833,000 | 804,000 | 660,000 | 341,000 |
| Total Russia in Asia | 22,148,000 | 28,827,000 | 23,431,000 | 31,183,000 | 16,194,000 |
| Japan | 30,321,000 | 31,563,000 | 37,710,000 | 34,000,000 | 35,000,000 |
| Total | 1,499,250,000 | 1,306,022,000 | 1,465,254,000 | 1,617,967,000 | 1,601,826,000 |

*Visible supply of rye in the United States the first of each month for ten years.*

| Month. | 1891–1892. | 1892–1893. | 1893–1894. | 1894–1895. | 1895–1896. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| July | 317,219 | 450,624 | 480,000 | 289,000 | 158,000 |
| August | 630,000 | 258,000 | 408,000 | 263,000 | 215,000 |
| September | 2,570,644 | 470,036 | 434,000 | 372,000 | 511,000 |
| October | 2,440,858 | 951,978 | 582,000 | 411,000 | 700,000 |
| November | 2,832,634 | 1,308,752 | 658,000 | 556,000 | 1,250,000 |
| December | 2,743,291 | 1,575,914 | 723,000 | 508,000 | 1,702,000 |
| January | 2,674,920 | 1,442,059 | 717,000 | 583,000 | 1,739,000 |
| February | 2,476,618 | 1,157,000 | 720,000 | 508,000 | 1,763,000 |
| March | 2,241,847 | 1,139,000 | 638,000 | 423,000 | 1,710,000 |
| April | 1,970,586 | 1,046,000 | 532,000 | 366,000 | 1,631,000 |
| May | 1,035,611 | 906,000 | 489,000 | 182,000 | 1,481,000 |
| June | 836,102 | 675,000 | 302,000 | 177,000 | 1,467,000 |

*Visible supply of rye in the United States the first of each month for ten years*—Continued.

| Month. | 1896–1897. | 1897–1898. | 1898–1899. | 1899–1900. | 1900–1901. |
|---|---|---|---|---|---|
| | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* | *Bushels.* |
| July | 1,575,000 | 2,464,000 | 988,000 | 904,000 | 806,000 |
| August | 1,630,000 | 1,946,000 | 365,000 | 638,000 | 725,000 |
| September | 2,328,000 | 2,499,000 | 721,000 | 647,000 | 1,056,000 |
| October | 2,040,000 | 3,064,000 | 894,000 | 962,000 | 1,216,000 |
| November | 2,596,000 | 3,832,000 | 1,260,000 | 1,906,000 | 1,513,000 |
| December | 2,695,000 | 3,932,000 | 1,212,000 | 1,892,000 | 1,754,000 |
| January | 3,276,000 | 4,436,000 | 1,573,000 | 1,806,000 | 1,651,000 |
| February | 4,266,000 | 4,291,000 | 1,576,000 | 1,734,000 | 1,530,000 |
| March | 4,104,000 | 4,099,000 | 1,724,000 | 1,951,000 | 1,532,000 |
| April | 4,128,000 | 3,682,000 | 1,658,000 | 1,566,000 | 1,333,000 |
| May | 3,607,000 | 3,039,000 | 1,335,000 | 1,441,000 | ........ |
| June | 2,798,000 | 1,526,000 | 975,000 | 1,206,000 | ........ |

*Condition of the rye crop of the United States, monthly, 1885–1900.*

| Year. | April. | May. | June. | July. | August. | When harvested. | | April. | May. | June. | July. | August. | When harvested. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1885 | 87.7 | 86.0 | 83.0 | 87.0 | 94.0 | ...... | 1893 | 85.7 | 82.7 | 84.6 | 83.8 | 78.5 | 82.0 |
| 1886 | 96.6 | 95.7 | 94.4 | 95.6 | 88.6 | 93.4 | 1894 | 94.4 | 90.7 | 93.2 | 93.9 | 79.8 | 86.9 |
| 1887 | 92.0 | 90.8 | 88.9 | 88.0 | 84.6 | 82.2 | 1895 | 87.0 | 88.7 | 85.7 | 82.2 | 84.0 | 83.7 |
| 1888 | 93.5 | 92.9 | 93.9 | 95.1 | 91.4 | 92.8 | 1896 | 82.9 | 87.7 | 85.2 | 83.8 | 88.0 | 82.0 |
| 1889 | 93.9 | 96.5 | 95.2 | 96.7 | 95.4 | 91.6 | 1897 | 88.9 | 88.0 | 89.9 | 95.0 | 89.8 | 90.1 |
| 1890 | 92.8 | 93.5 | 92.3 | 92.0 | 86.8 | 85.4 | 1898 | 92.1 | 94.5 | 97.1 | 93.8 | 93.7 | 89.4 |
| 1891 | 95.4 | 97.2 | 95.4 | 93.9 | 89.6 | 95.1 | 1899 | 84.9 | 85.2 | 84.5 | 83.3 | 89.0 | 82.0 |
| 1892 | 87.0 | 88.9 | 91.0 | 92.9 | 89.8 | 88.5 | 1900 | 84.8 | 88.5 | 87.6 | 89.6 | 76.0 | 84.2 |

*Acreage, production, value, prices, and exports of rye of the United States, 1866 to 1900, inclusive.*

| Year. | Acreage. | Average yield per acre. | Production. | Average farm price per bushel, Dec. 1. | Farm value, Dec. 1. | Chicago cash price per bushel, No. 2. December. Low. | Chicago cash price per bushel, No. 2. December. High. | Chicago cash price per bushel, No. 2. May of following year. Low. | Chicago cash price per bushel, No. 2. May of following year. High. | Domestic exports, including rye flour, fiscal years beginning July 1. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Acres.* | *Bush.* | *Bushels.* | *Cents.* | *Dollars.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Bushels.* |
| 1866 | 1,548,033 | 13.5 | 20,864,944 | 82.2 | 17,149,716 | ...... | ...... | 142 | 150 | 234,971 |
| 1867 | 1,689,175 | 13.7 | 23,184,000 | 100.4 | 23,280,584 | 132 | 157 | 173 | 185 | 564,901 |
| 1868 | 1,651,321 | 13.6 | 22,504,800 | 94.9 | 21,349,190 | 106½ | 118 | 100 | 115½ | 92,869 |
| 1869 | 1,657,584 | 13.6 | 22,527,900 | 77.0 | 17,341,861 | 66 | 77½ | 78 | 83½ | 199,450 |
| 1870 | 1,176,137 | 13.2 | 15,473,600 | 73.2 | 11,326,967 | 67 | 74 | 81 | 91 | 87,174 |
| 1871 | 1,069,531 | 14.4 | 15,365,500 | 71.1 | 10,927,623 | 62 | 63¾ | 75 | 93 | 832,689 |
| 1872 | 1,048,654 | 14.2 | 14,888,600 | 67.6 | 10,071,061 | 57½ | 70 | 68½ | 70 | 611,749 |
| 1873 | 1,150,355 | 13.2 | 15,142,000 | 70.3 | 10,638,258 | 70 | 81 | 91 | 102 | 1,923,404 |
| 1874 | 1,116,716 | 13.4 | 14,990,900 | 77.4 | 11,610,339 | 93 | 99½ | 103 | 107½ | 267,058 |
| 1875 | 1,359,788 | 13.0 | 17,722,100 | 67.1 | 11,894,223 | 67 | 68¾ | 61½ | 70½ | 589,159 |
| 1876 | 1,468,374 | 13.9 | 20,374,800 | 61.4 | 12,504,970 | 65½ | 73 | 70 | 92½ | 2,234,856 |
| 1877 | 1,412,902 | 15.0 | 21,170,100 | 57.6 | 12,201,759 | 55½ | 56½ | 54 | 60 | 4,249,684 |
| 1878 | 1,622,700 | 15.9 | 25,842,790 | 52.5 | 13,566,002 | 44 | 44½ | 47 | 52 | 4,877,821 |
| 1879 | 1,625,450 | 14.5 | 23,639,460 | 65.6 | 15,507,431 | 73½ | 81 | 73½ | 85 | 2,943,894 |
| 1880 | 1,767,619 | 13.9 | 24,540,829 | 75.6 | 18,564,560 | 82 | 91½ | 115 | 118 | 1,955,155 |
| 1881 | 1,789,100 | 11.6 | 20,704,950 | 93.3 | 19.327,415 | 96½ | 98 | 77 | 83 | 1,003,609 |
| 1882 | 2,227,894 | 13.4 | 29,960,037 | 61.5 | 18,439,194 | 57 | 58½ | 62 | 67 | 2,206,212 |
| 1883 | 2,314,754 | 12.1 | 28,058,582 | 58.1 | 16,300,503 | 56½ | 60 | 60½ | 62½ | 6,247,590 |
| 1884 | 2,343,963 | 12.2 | 28,640,000 | 51.9 | 14,857,040 | 51 | 52 | 68 | 73 | 2,974,390 |
| 1885 | 2,129,301 | 10.2 | 21,756,000 | 57.9 | 12,594,820 | 58½ | 61 | 58 | 61 | 216,699 |
| 1886 | 2,129,918 | 11.5 | 24,489,000 | 53.8 | 13,181,330 | 53 | 54½ | 54½ | 56½ | 377,302 |
| 1887 | 2,053,447 | 10.1 | 20,693,000 | 54.5 | 11,283,140 | 55½ | 61½ | 63 | 68 | 94,827 |
| 1888 | 2,364,805 | 12.0 | 28,415,000 | 58.8 | 16,721,869 | 50 | 52 | 39 | 41½ | 309,266 |
| 1889 | 2,171,493 | 13.1 | 28,420,299 | 42.3 | 12,009,752 | 44 | 45½ | 49½ | 54 | 2,280,975 |
| 1890 | 2,141,853 | 12.0 | 25,807,472 | 62.9 | 16,229,992 | 64½ | 68½ | 83 | 92 | 358,263 |
| 1891 | 2,176,466 | 14.6 | 31,751,868 | 77.4 | 24,589,217 | 86 | 92 | 70¼ | 79 | 12,068,628 |
| 1892 | 2,163,657 | 12.9 | 27,978,824 | 54.2 | 15,160,056 | 46 | 51 | 50½ | 62 | 1,493,924 |
| 1893 | 2,038,485 | 13.0 | 26,555,446 | 51.3 | 13,612,222 | 45 | 47½ | 44½ | 48 | 249,152 |
| 1894 | 1,944,780 | 13.7 | 26,727,615 | 50.1 | 13,395,476 | 47½ | 49 | 62½ | 67 | 32,045 |
| 1895 | 1,890,345 | 14.4 | 27,210,070 | 44.0 | 11,964,826 | 32 | 35¾ | 33 | 36½ | 1,011,128 |
| 1896 | 1,831,201 | 13.3 | 24,369,047 | 40.9 | 9,960,769 | 37 | 42½ | 32¾ | 35½ | 8,575,667 |
| 1897 | 1,703,561 | 16.1 | 27,363,324 | 44.7 | 12,239,647 | 45¾ | 47 | 48 | 75 | 15,562,035 |
| 1898 | 1,643,207 | 15.6 | 25,657,522 | 46.3 | 11,875,350 | 52½ | 55½ | 56½ | 62 | 10,169,822 |
| 1899 | 1,659,308 | 14.4 | 23,961,741 | 51.0 | 12,214,118 | 49 | 52 | 53 | 56¼ | 2,382,012 |
| 1900 | 1,591,362 | 15.1 | 23,995,927 | 51.2 | 12,295,417 | 45¾ | 49¾ | ...... | ...... | .......... |

*Acreage, production, and value of rye in the United States in 1900, by States.*

| States and Territories. | Acreage. | Average yield per acre. | Production. | Average farm price Dec. 1. | Average value per acre. | Farm value Dec. 1. |
|---|---|---|---|---|---|---|
| | *Acres.* | *Bushels.* | *Bushels.* | *Cents.* | *Dollars.* | *Dollars.* |
| Maine | 993 | 17.2 | 17,080 | 82 | 14.10 | 14,006 |
| New Hampshire | 887 | 17.1 | 15,168 | 82 | 14.02 | 12,438 |
| Vermont | 2,887 | 16.6 | 47,924 | 61 | 10.13 | 29,234 |
| Massachusetts | 7,914 | 16.9 | 133,747 | 75 | 12.68 | 100,310 |
| Connecticut | 14,106 | 17.0 | 239,802 | 65 | 11.05 | 155,871 |
| New York | 211,203 | 15.1 | 3,189,165 | 56 | 8.46 | 1,785,932 |
| New Jersey | 64,717 | 15.9 | 1,029,000 | 55 | 8.74 | 565,950 |
| Pennsylvania | 288,647 | 15.3 | 4,416,299 | 53 | 8.11 | 2,340,638 |
| Maryland | 24,729 | 16.5 | 408,028 | 52 | 8.58 | 212,175 |
| Virginia | 35,250 | 10.5 | 370,125 | 58 | 6.09 | 214,672 |
| North Carolina | 46,212 | 8.9 | 411,287 | 76 | 6.76 | 312,578 |
| South Carolina | 3,902 | 7.5 | 29,265 | 105 | 7.87 | 30,728 |
| Georgia | 15,647 | 7.0 | 109,529 | 103 | 7.21 | 112,815 |
| Alabama | 1,804 | 7.8 | 14,071 | 103 | 8.03 | 14,493 |
| Texas | 3,917 | 16.5 | 64,630 | 67 | 11.05 | 43,302 |
| Arkansas | 1,715 | 11.5 | 19,722 | 72 | 8.28 | 14,200 |
| Tennessee | 11,297 | 11.0 | 124,267 | 68 | 7.48 | 84,502 |
| West Virginia | 12,171 | 10.5 | 127,796 | 64 | 6.72 | 81,789 |
| Kentucky | 22,488 | 13.1 | 294,593 | 63 | 8.25 | 185,594 |
| Ohio | 30,905 | 16.6 | 513,023 | 55 | 9.13 | 282,163 |
| Michigan | 71,306 | 14.6 | 1,041,068 | 48 | 7.01 | 499,713 |
| Indiana | 32,167 | 15.1 | 485,722 | 50 | 7.55 | 242,861 |
| Illinois | 73,877 | 17.2 | 1,270,684 | 47 | 8.08 | 597,221 |
| Wisconsin | 190,534 | 15.8 | 3,010,437 | 49 | 7.74 | 1,475,114 |
| Minnesota | 53,151 | 19.5 | 1,036,444 | 42 | 8.19 | 435,306 |
| Iowa | 100,365 | 18.0 | 1,806,570 | 41 | 7.38 | 740,694 |
| Missouri | 9,607 | 14.0 | 134,498 | 51 | 7.14 | 68,594 |
| Kansas | 126,479 | 15.2 | 1,922,481 | 43 | 6.54 | 826,667 |
| Nebraska | 61,073 | 14.2 | 867,237 | 40 | 5.68 | 346,895 |
| South Dakota | 2,623 | 10.6 | 27,804 | 39 | 4.13 | 10,844 |
| North Dakota | 16,152 | 5.2 | 83,990 | 41 | 2.13 | 34,436 |
| Colorado | 2,350 | 16.8 | 39,480 | 54 | 9.07 | 21,319 |
| Utah | 3,383 | 17.5 | 59,202 | 52 | 9.10 | 30,785 |
| Washington | 2,403 | 16.3 | 39,169 | 58 | 9.45 | 22,718 |
| Oregon | 5,841 | 16.1 | 94,040 | 61 | 9.82 | 57,364 |
| California | 38,660 | 13.0 | 502,580 | 58 | 7.54 | 291,496 |
| United States | 1,591,362 | 15.1 | 23,995,927 | 51.2 | 7.73 | 12,295,417 |

*Average yield per acre of rye in the United States, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* |
| Maine | 16.0 | 13.5 | 12.0 | 16.5 | 19.2 | 18.0 | 13.5 | 18.0 | 15.0 | 17.2 |
| New Hampshire | 16.2 | 14.0 | 15.1 | 15.4 | 16.0 | 19.6 | 18.0 | 17.5 | 15.0 | 17.1 |
| Vermont | 16.1 | 14.3 | 14.0 | 13.1 | 16.0 | 18.6 | 16.0 | 19.1 | 17.0 | 16.6 |
| Massachusetts | 15.3 | 15.2 | 16.2 | 19.2 | 19.9 | 22.0 | 19.5 | 16.7 | 16.0 | 16.9 |
| Connecticut | 14.3 | 14.3 | 15.9 | 12.9 | 16.9 | 15.4 | 19.0 | 18.0 | 18.0 | 17.0 |
| New York | 15.0 | 12.7 | 14.9 | 15.4 | 18.1 | 14.3 | 18.5 | 17.5 | 16.0 | 15.1 |
| New Jersey | 14.3 | 13.5 | 13.4 | 14.8 | 13.6 | 13.8 | 17.0 | 15.5 | 15.0 | 15.9 |
| Pennsylvania | 14.8 | 12.6 | 14.7 | 13.9 | 15.1 | 16.0 | 19.0 | 16.1 | 15.0 | 15.3 |
| Maryland | 12.2 | 11.3 | 13.1 | 13.5 | 12.9 | 9.2 | 17.0 | 14.5 | 14.0 | 16.5 |
| Virginia | 8.2 | 8.8 | 9.3 | 8.8 | 11.0 | 10.0 | 11.0 | 11.2 | 9.0 | 10.5 |
| North Carolina | 7.0 | 6.5 | 7.7 | 9.0 | 7.7 | 7.5 | 8.8 | 9.1 | 7.0 | 8.9 |
| South Carolina | 6.0 | 6.0 | 5.4 | 4.7 | 9.3 | 4.8 | 6.6 | 8.5 | 5.0 | 7.5 |
| Georgia | 7.6 | 6.0 | 6.4 | 6.5 | 7.2 | 7.1 | 7.4 | 8.0 | 6.0 | 7.0 |
| Alabama | 7.5 | 6.5 | 9.8 | 13.3 | 10.2 | 8.0 | 9.6 | 11.1 | 8.0 | 7.8 |
| Texas | 11.2 | 11.2 | 9.3 | 11.3 | 5.5 | 7.0 | 12.0 | 12.0 | 10.0 | 16.5 |
| Arkansas | 9.3 | 8.2 | 7.5 | 9.0 | 10.0 | 10.0 | 11.0 | 11.4 | 11.0 | 11.5 |
| Tennessee | 8.7 | 8.7 | 9.5 | 7.6 | 7.2 | 9.0 | 10.0 | 10.5 | 9.0 | 11.0 |
| West Virginia | 10.5 | 9.5 | 8.2 | 8.0 | 16.1 | 10.6 | 11.5 | 11.2 | 10.0 | 10.5 |
| Kentucky | 10.3 | 11.3 | 13.2 | 12.2 | 13.2 | 11.0 | 13.0 | 13.0 | 10.0 | 13.1 |
| Ohio | 15.5 | 12.6 | 15.2 | 18.3 | 14.8 | 9.6 | 18.0 | 17.4 | 16.0 | 16.6 |
| Michigan | 15.0 | 13.7 | 12.8 | 13.2 | 13.6 | 9.2 | 15.0 | 15.3 | 14.0 | 14.6 |
| Indiana | 17.2 | 12.5 | 14.4 | 19.3 | 12.2 | 10.6 | 13.0 | 15.5 | 13.0 | 15.1 |
| Illinois | 17.5 | 12.3 | 13.9 | 18.6 | 15.2 | 15.3 | 15.5 | 14.8 | 15.0 | 17.2 |
| Wisconsin | 14.6 | 13.7 | 14.5 | 16.0 | 16.1 | 14.5 | 16.0 | 15.3 | 15.0 | 15.8 |
| Minnesota | 17.2 | 17.1 | 15.3 | 17.5 | 21.1 | 15.6 | 17.2 | 20.5 | 18.0 | 19.5 |
| Iowa | 17.0 | 13.2 | 14.6 | 16.9 | 20.6 | 17.5 | 16.0 | 19.0 | 18.0 | 18.0 |
| Missouri | 13.5 | 12.5 | 12.8 | 15.4 | 12.2 | 12.2 | 12.0 | 13.1 | 13.0 | 14.0 |
| Kansas | 14.3 | 15.0 | 7.0 | 5.8 | 5.9 | 7.0 | 14.0 | 15.6 | 11.0 | 15.2 |
| Nebraska | 15.7 | 14.5 | 10.1 | 6.1 | 9.3 | 16.9 | 17.0 | 18.8 | 16.0 | 14.2 |
| South Dakota | 15.3 | 12.5 | 10.6 | 4.5 | 8.4 | 11.6 | 16.5 | 16.6 | 15.0 | 10.6 |
| North Dakota | 17.5 | 11.8 | 12.3 | 15.0 | 21.3 | 12.0 | 14.5 | 15.0 | 15.0 | 5.2 |

*Average yield per acre of rye in the United States, 1891–1900, by States*—Continued.

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* |
| Colorado | 20.6 | 14.6 | 21.0 | 15.6 | 14.5 | 23.5 | 15.0 | 18.0 | 14.0 | 16.8 |
| Utah | 16.8 | 13.2 | 11.9 | 19.0 | 19.8 | 20.0 | 12.0 | 19.5 | 17.0 | 17.5 |
| Washington | 14.3 | 17.0 | 15.1 | 14.4 | 26.7 | 15.0 | 19.5 | 18.0 | 16.0 | 16.3 |
| Oregon | 13.8 | 12.0 | 10.5 | 14.1 | 11.2 | 12.7 | 15.0 | 14.4 | 11.0 | 16.1 |
| California | 16.5 | 11.5 | 17.5 | 13.2 | 11.6 | 14.3 | 12.2 | 9.0 | 15.0 | 13.0 |
| General average | 14.40 | 12.70 | 13.03 | 13.74 | 14.40 | 13.31 | 16.06 | 15.61 | 14.44 | 15.1 |

*Average yield of rye in certain countries, in bushels per acre, 1894–1899.*

| Year. | United States. | Russia. | Germany. | Austria. | Hungary. | France. | Ireland. |
|---|---|---|---|---|---|---|---|
| | [1] | [2] | [2] | [1] | [1] | [1] | |
| 1894 | 13.7 | 12.7 | 22.0 | 17.7 | 19.3 | 19.5 | 25.4 |
| 1895 | 14.4 | 11.6 | 20.9 | 14.8 | 16.8 | 18.8 | 26.8 |
| 1896 | 13.3 | 10.9 | 22.7 | 16.9 | 18.3 | 18.7 | 25.4 |
| 1897 | 16.1 | 9.3 | 21.8 | 14.5 | 13.9 | 13.4 | 21.6 |
| 1898 | 15.6 | 10.5 | 24.2 | 18.0 | 17.1 | 18.3 | 25.8 |
| 1899 | 14.4 | 12.8 | 23.6 | 19.3 | 17.8 | 18.2 | 25.7 |
| Average | 14.6 | 11.3 | 22.5 | 16.9 | 17.2 | 17.8 | 25.1 |

[1] Winchester bushels. [2] Bushels of 56 pounds.

*Average value per acre of rye in the United States, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| Maine | $15.52 | $11.34 | $12.96 | $13.37 | $16.32 | $12.06 | $11.07 | $15.12 | $12.60 | $14.10 |
| New Hampshire | 15.39 | 11.62 | 11.78 | 11.40 | 12.16 | 14.11 | 15.12 | 13.12 | 12.15 | 14.02 |
| Vermont | 14.49 | 10.44 | 10.22 | 9.56 | 9.12 | 12.09 | 9.60 | 11.08 | 10.54 | 10.13 |
| Massachusetts | 14.69 | 10.94 | 12.15 | 14.02 | 13.33 | 15.40 | 11.90 | 10.52 | 12.64 | 12.68 |
| Connecticut | 13.44 | 10.44 | 10.49 | 8.39 | 10.65 | 8.78 | 11.21 | 10.80 | 11.52 | 11.05 |
| New York | 13.20 | 8.26 | 9.39 | 8.32 | 8.69 | 6.29 | 8.88 | 8.75 | 8.96 | 8.46 |
| New Jersey | 11.73 | 8.37 | 9.38 | 8.14 | 6.94 | 6.49 | 8.50 | 7.75 | 8.25 | 8.74 |
| Pennsylvania | 11.84 | 7.81 | 8.38 | 7.78 | 7.55 | 7.52 | 8.17 | 7.57 | 7.65 | 8.11 |
| Maryland | 10.74 | 7.01 | 6.68 | 6.35 | 6.32 | 4.42 | 7.82 | 7.83 | 7.98 | 8.58 |
| Virginia | 6.72 | 5.54 | 5.21 | 4.75 | 5.72 | 4.80 | 5.50 | 5.15 | 4.77 | 6.09 |
| North Carolina | 5.95 | 5.52 | 5.39 | 6.30 | 4.93 | 5.32 | 5.28 | 5.82 | 5.25 | 6.76 |
| South Carolina | 6.42 | 5.88 | 5.94 | 4.51 | 10.70 | 4.18 | 5.68 | 8.67 | 5.45 | 7.87 |
| Georgia | 8.74 | 6.00 | 6.91 | 6.31 | 6.12 | 7.17 | 6.81 | 7.84 | 6.72 | 7.21 |
| Alabama | 8.40 | 6.50 | 11.27 | 12.64 | 8.57 | 7.04 | 11.33 | 11.65 | 8.32 | 8.03 |
| Texas | 8.96 | 7.84 | 6.32 | 8.48 | 4.13 | 4.69 | 8.64 | 8.52 | 8.20 | 11.05 |
| Arkansas | 8.18 | 6.72 | 4.35 | 6.84 | 6.20 | 7.00 | 9.46 | 7.41 | 8.14 | 8.28 |
| Tennessee | 7.40 | 5.65 | 5.60 | 4.48 | 4.46 | 5.40 | 5.80 | 5.56 | 6.03 | 7.48 |
| West Virginia | 7.98 | 6.37 | 5.33 | 4.56 | 9.82 | 5.94 | 5.87 | 5.82 | 6.20 | 6.72 |
| Kentucky | 8.55 | 7.01 | 7.66 | 7.20 | 7.39 | 5.94 | 6.89 | 7.15 | 7.00 | 8.25 |
| Ohio | 13.18 | 7.06 | 7.14 | 8.23 | 6.66 | 3.74 | 7.92 | 7.83 | 8.80 | 9.13 |
| Michigan | 11.70 | 7.26 | 5.63 | 6.07 | 5.44 | 2.94 | 6.30 | 6.58 | 7.28 | 7.01 |
| Indiana | 13.42 | 6.50 | 6.48 | 8.11 | 5.12 | 3.82 | 5.46 | 6.67 | 6.24 | 7.55 |
| Illinois | 13.48 | 6.15 | 5.70 | 8.00 | 6.08 | 5.20 | 6.82 | 6.51 | 7.05 | 8.08 |
| Wisconsin | 11.39 | 6.58 | 6.24 | 6.88 | 5.64 | 4.82 | 6.56 | 6.58 | 7.20 | 7.74 |
| Minnesota | 11.70 | 7.52 | 6.27 | 7.53 | 5.91 | 4.68 | 6.36 | 7.79 | 7.56 | 8.19 |
| Iowa | 11.39 | 6.47 | 5.99 | 7.77 | 6.39 | 5.08 | 5.76 | 7.60 | 7.20 | 7.38 |
| Missouri | 9.86 | 6.25 | 5.76 | 7.24 | 4.76 | 5.73 | 5.28 | 6.16 | 6.50 | 7.14 |
| Kansas | 9.15 | 6.00 | 2.66 | 2.67 | 2.24 | 2.45 | 5.60 | 5.77 | 4.62 | 6.54 |
| Nebraska | 9.42 | 5.65 | 3.54 | 2.93 | 2.79 | 3.72 | 5.44 | 6.39 | 6.08 | 5.68 |
| South Dakota | 9.18 | 4.62 | 3.92 | 2.07 | 2.10 | 3.13 | 5.78 | 5.64 | 5.55 | 4.13 |
| North Dakota | 11.38 | 5.19 | 3.94 | 5.55 | 5.75 | 2.64 | 5.22 | 5.40 | 5.55 | 2.13 |
| Colorado | 12.77 | 7.59 | 10.50 | 10.30 | 6.96 | 14.57 | 7.80 | 9.60 | 6.72 | 9.07 |
| Utah | 10.75 | 7.26 | 5.59 | 10.83 | 6.93 | 8.00 | 7.20 | 8.97 | 8.16 | 9.10 |
| Washington | 11.73 | 9.35 | 10.42 | 8.06 | 20.03 | 7.50 | 12.09 | 10.44 | 9.60 | 9.45 |
| Oregon | 11.04 | 7.20 | 7.66 | 8.04 | 6.05 | 7.62 | 8.85 | 10.37 | 7.70 | 9.82 |
| California | 14.85 | 7.70 | 10.50 | 7.92 | 6.73 | 8.70 | 7.93 | 6.30 | 11.70 | 7.54 |
| General average | 11.30 | 6.98 | 6.68 | 6.89 | 6.33 | 5.44 | 7.18 | 7.23 | 7.36 | 7.73 |

*Average farm price of rye per bushel in the United States December 1, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| Maine | 97 | 84 | 108 | 81 | 85 | 67 | 82 | 84 | 84 | 82 |
| New Hampshire | 95 | 83 | 78 | 74 | 76 | 72 | 84 | 75 | 81 | 82 |
| Vermont | 90 | 73 | 73 | 73 | 57 | 65 | 60 | 58 | 62 | 61 |
| Massachusetts | 96 | 72 | 75 | 73 | 67 | 70 | 61 | 63 | 79 | 75 |
| Connecticut | 94 | 73 | 66 | 65 | 63 | 57 | 59 | 60 | 64 | 65 |
| New York | 88 | 65 | 63 | 54 | 48 | 44 | 48 | 50 | 56 | 56 |
| New Jersey | 82 | 62 | 70 | 55 | 51 | 47 | 50 | 50 | 55 | 55 |
| Pennsylvania | 80 | 62 | 57 | 56 | 50 | 47 | 43 | 47 | 51 | 53 |
| Maryland | 88 | 62 | 51 | 47 | 49 | 48 | 46 | 54 | 57 | 52 |
| Virginia | 82 | 63 | 56 | 54 | 52 | 48 | 50 | 46 | 53 | 58 |
| North Carolina | 85 | 85 | 70 | 70 | 64 | 71 | 60 | 64 | 75 | 76 |
| South Carolina | 107 | 98 | 110 | 96 | 115 | 87 | 86 | 102 | 109 | 105 |
| Georgia | 115 | 100 | 108 | 97 | 85 | 101 | 92 | 98 | 112 | 103 |
| Alabama | 112 | 100 | 115 | 95 | 84 | 88 | 118 | 105 | 104 | 103 |
| Texas | 80 | 70 | 68 | 75 | 75 | 67 | 72 | 71 | 82 | 67 |
| Arkansas | 88 | 82 | 58 | 76 | 72 | 70 | 86 | 65 | 74 | 72 |
| Tennessee | 85 | 65 | 59 | 59 | 62 | 60 | 58 | 53 | 67 | 68 |
| West Virginia | 76 | 67 | 65 | 57 | 61 | 56 | 51 | 52 | 62 | 64 |
| Kentucky | 83 | 62 | 58 | 59 | 56 | 54 | 53 | 55 | 70 | 63 |
| Ohio | 85 | 56 | 47 | 45 | 45 | 39 | 44 | 45 | 55 | 55 |
| Michigan | 78 | 53 | 44 | 46 | 40 | 32 | 42 | 43 | 52 | 48 |
| Indiana | 78 | 52 | 45 | 42 | 42 | 36 | 42 | 43 | 48 | 50 |
| Illinois | 77 | 50 | 41 | 43 | 40 | 34 | 44 | 44 | 47 | 47 |
| Wisconsin | 78 | 48 | 43 | 43 | 35 | 33 | 41 | 43 | 48 | 49 |
| Minnesota | 68 | 44 | 41 | 43 | 28 | 30 | 37 | 38 | 42 | 42 |
| Iowa | 67 | 49 | 41 | 46 | 31 | 29 | 36 | 40 | 40 | 41 |
| Missouri | 73 | 50 | 45 | 47 | 39 | 47 | 44 | 47 | 50 | 51 |
| Kansas | 64 | 40 | 38 | 46 | 38 | 35 | 40 | 37 | 42 | 43 |
| Nebraska | 60 | 39 | 35 | 48 | 30 | 22 | 32 | 34 | 38 | 40 |
| South Dakota | 60 | 37 | 37 | 46 | 25 | 27 | 35 | 34 | 37 | 39 |
| North Dakota | 65 | 44 | 32 | 37 | 27 | 22 | 36 | 36 | 37 | 41 |
| Colorado | 62 | 52 | 50 | 66 | 48 | 62 | 52 | 50 | 48 | 54 |
| Utah | 64 | 55 | 47 | 57 | 35 | 40 | 60 | 46 | 48 | 52 |
| Washington | 82 | 55 | 69 | 56 | 75 | 50 | 62 | 58 | 60 | 58 |
| Oregon | 80 | 60 | 73 | 57 | 54 | 60 | 59 | 72 | 70 | 61 |
| California | 90 | 67 | 60 | 60 | 58 | 60 | 65 | 70 | 78 | 58 |
| General average | 77.44 | 54.18 | 51.26 | 50.12 | 43.97 | 40.87 | 44.73 | 46.28 | 50.97 | 51.2 |

*Wholesale prices of rye per bushel in leading cities of the United States, 1896–1900.*

| Date. | New York. | | Cincinnati. | | Chicago. | | Duluth. | |
|---|---|---|---|---|---|---|---|---|
| | Prime State. | | No. 2. | | No. 2. | | | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| **1896.** | | | | | | | | |
| January | 45 | 45 | 37¾ | 44 | 32½ | 41¼ | 29 | 34 |
| February | 44 | 50 | 41¼ | 44 | 38 | 41 | 34 | 35½ |
| March | 47½ | 49 | 39 | 42 | 35¼ | 40 | 33½ | 36 |
| April | 44¾ | 47½ | 40 | 44 | 35¼ | 37½ | 34 | 36 |
| May | 43½ | 45¾ | 36 | 44 | 33 | 36½ | 32½ | 35½ |
| June | 37 | 44 | 33 | 36 | 28½ | 34 | 28½ | 32½ |
| July | 35½ | 40 | 26½ | 35 | 29 | 31¾ | 29½ | 30 |
| August | 36½ | 40 | 29½ | 35 | 28 | 32 | 28½ | 33 |
| September | 38 | 42 | 30½ | 36½ | 30¼ | 36 | 31 | 36 |
| October | 39 | 48 | 36½ | 43 | 34 | 41 | 34 | 40 |
| November | 40 | 44 | 35 | 40 | 36 | 43 | 34 | 40 |
| December | 32 | 44 | 35 | 42 | 37 | 42½ | 36 | 39 |
| **1897.** | | | | | | | | |
| January | 40 | 46 | 36 | 44 | 35¼ | 38¼ | 34 | 39 |
| February | 39 | 45 | 36 | 42 | 32½ | 36 | 33 | 35¼ |
| March | 40 | 44 | 36 | 41½ | 32 | 34½ | 32½ | 35 |
| April | 37 | 45 | 36 | 39 | 31¾ | 36¾ | 30 | 37½ |
| May | 38 | 43 | 35 | 42½ | 32¾ | 35½ | 33 | 35½ |
| June | 38 | 42 | 33 | 39 | 32½ | 35 | 33½ | 35 |
| July | 38 | 46 | 33 | 36 | 34 | 42 | 34 | 41½ |
| August | 42 | 55 | 35 | 52 | 41 | 56 | 42 | 53 |
| September | 47 | 58 | 46 | 50 | 46¼ | 53 | 45 | 52½ |
| October | 52 | 54½ | 45 | 47 | 44 | 47½ | 44 | 48 |
| November | 53 | 54⅛ | 46 | 47 | 45 | 48 | 45 | 47½ |
| December | 53 | 55 | 46 | 48 | 45¾ | 47 | 45½ | 46¾ |
| **1898.** | | | | | | | | |
| January | 54¼ | 57½ | 45½ | 53 | 44½ | 48 | 45 | 47½ |
| February | 55½ | 59½ | 48 | 53 | 46¾ | 50½ | 46¼ | 50 |
| March | 58 | 60 | 52 | 54½ | 48¾ | 50½ | 48 | 49½ |
| April | 57½ | 69 | 52 | 66 | 50 | 62 | 49 | 62¼ |
| May | 60 | 74¾ | 52 | 80 | 48 | 75 | 48 | 72 |
| June | 49 | 58 | 40 | 51 | 41 | 49 | 41 | 51 |

*Wholesale prices of rye per bushel in leading cities of the United States, 1896–1900*—Cont'd.

| Date. | New York. Prime State. | | Cincinnati. No. 2. | | Chicago. No. 2. | | Duluth. | |
|---|---|---|---|---|---|---|---|---|
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| 1898. | | | | | | | | |
| July | 50 | 55½ | 40 | 45 | 42¾ | 48½ | 41½ | 48½ |
| August | 49½ | 52½ | 45 | 50 | 41 | 46½ | 40½ | 45½ |
| September | 50 | 54½ | 45 | 48½ | 42½ | 49 | 42¾ | 47 |
| October | 53 | 60 | 48 | 57 | 44½ | 51½ | 44 | 50 |
| November | 58 | 60 | 56 | 59 | 49½ | 52¾ | 50 | 51 |
| December | 59¼ | 64 | 56 | 58½ | 52½ | 55½ | 50 | 54 |
| 1899. | | | | | | | | |
| January | 63¾ | 67½ | 57 | 65 | 53½ | 58¾ | 53 | 58 |
| February | 64½ | 68 | 60 | 65 | 54 | 56¼ | 54½ | 56 |
| March | 63 | 67½ | 59 | 65 | 49¼ | 56½ | 48½ | 55¾ |
| April | 63 | 68½ | 60 | 65 | 52 | 59 | 50½ | 58 |
| May | 65 | 67 | 62 | 68 | 56½ | 62 | 56 | 58½ |
| June | 64 | 66½ | 64 | 68 | 56 | 62 | 56 | 59½ |
| July | 60 | 65½ | 57 | 67 | 51 | 60 | 50 | 58 |
| August | 59 | 61¾ | 56 | 60 | 51½ | 56½ | 50½ | 53½ |
| September | 61½ | 66 | 58 | 65 | 54 | 58 | 52¾ | 57½ |
| October | 61 | 63 | 61½ | 65½ | 54¼ | 58 | 53 | 57¼ |
| November | 56 | 62 | 59 | 64 | 49 | 53 | 48 | 52 |
| December | 58½ | 61½ | 60 | 65½ | 49 | 52 | 47 | 49½ |
| 1900. | | | | | | | | |
| January | 60 | 61¼ | 59 | 64 | 50 | 52 | 48½ | 50 |
| February | 60½ | 64½ | 61 | 65 | 51 | 55½ | 50 | 53 |
| March | 60½ | 63½ | 60 | 64 | 52½ | 55 | 51 | 53½ |
| April | 60½ | 63½ | 60 | 63½ | 53 | 55½ | 51½ | 52½ |
| May | 60¼ | 62½ | 61 | 63½ | 53 | 56¼ | 51¾ | 53¾ |
| June | 61½ | 68 | 61 | 67 | 52¾ | 60½ | 52½ | 60½ |
| July | 57 | 65 | 59 | 66 | 50 | 58 | 49 | 57½ |
| August | 54½ | 58 | 51½ | 60 | 48 | 51½ | 48 | 50½ |
| September | 56¾ | 60½ | 53 | 57 | 50¼ | 53½ | 50 | 53½ |
| October | 56 | 61 | 55 | 59 | 47¼ | 52¼ | 48 | 53 |
| November | 54 | 56 | 52 | 56 | 44½ | 48 | 46 | 48¾ |
| December | 54 | 56 | 52 | 55½ | 45¾ | 49¾ | 46¼ | 48½ |

*Transportation rates, average for rye in sacks, in cents per 100 pounds, St. Louis to New Orleans by river.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1881 | 20.00 | 1886 | 16.00 | 1891 | 16.28 | 1896 | 14.55 |
| 1882 | 20.00 | 1887 | 18.25 | 1892 | 16.87 | 1897 | 15.00 |
| 1883 | 17.75 | 1888 | 15.00 | 1893 | 17.54 | 1898 | 10.00 |
| 1884 | 14.00 | 1889 | 17.93 | 1894 | 17.14 | 1899 | 10.00 |
| 1885 | 15.00 | 1890 | 15.66 | 1895 | 12.50 | 1900 | 10.00 |

## BUCKWHEAT.

The production of buckwheat in the United States has been small for the past thirty years as compared with the crops of the four years immediately succeeding the war. The acreage fell from 1,028,693 acres in 1869 to 536,992 in 1870, and the highest mark since reached was 917,915 acres in 1886. Since 1896 there has been a small but steady decrease in acreage, accompanied by an increase in farm price from 39 cents to 55.8 cents, of which 10.7 cents is shown in the change from 45 cents in 1898 to 55.7 in 1899. Exports of buckwheat since 1897 have been about a million and a half bushels annually, but in 1900 amounted to less than half a million. The export price advanced from 55.2 cents in 1899 to 57.7 in 1900.

The crop of 1900 was 9,566,966 bushels, a decrease from 1899 of 1,500,000 bushels upon an acreage decreased by 32,000 acres and a yield decreased by 1.6 bushels per acre. The average value per acre also fell from $9.23 to $8.37.

New York and Pennsylvania in nearly equal shares produce two-thirds of the buckwheat of the United States, while Maine, Michigan, and Wisconsin come in the second class, but each with only one-tenth the acreage of either of the leading States. Of the reduction in acreage noticed nearly 15,000 acres was in Pennsylvania and over 7,000 in New York.

The yield per acre increased in New York from 13 to 14 bushels, but fell in Pennsylvania from 20 bushels to 14, while the farm price went in New York from 59 cents to 57 and in Pennsylvania from 54 cents to 55. The value per acre in New York changed from $7.67 to $7.98, and in Pennsylvania from $10.80 to $7.70. The Pennsylvania crop of 1899, however, was quite unusual. The record for the eight years preceding shows the value per acre for the two States very close together, with the advantage usually in favor of New York.

*Condition of buckwheat crop of United States, monthly, 1885–1900.*

| Year. | Aug. | Sept. | Oct. | Year. | Aug. | Sept. | Oct. | Year. | Aug. | Sept. | Oct. | Year. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1885 | 94.0 | ...... | 92.0 | 1889 | 95.2 | 92.1 | 90.0 | 1893 | 88.8 | 77.5 | 73.5 | 1897 | 94.9 | 95.1 | 90.8 |
| 1886 | 94.1 | 89.8 | 86.5 | 1890 | 90.1 | 90.5 | 90.7 | 1894 | 82.3 | 69.2 | 72.0 | 1898 | 87.2 | 88.8 | 76.2 |
| 1887 | 93.3 | 89.1 | 76.6 | 1891 | 97.3 | 96.6 | 92.7 | 1895 | 85.2 | 87.5 | 84.8 | 1899 | 93.2 | 75.2 | 70.2 |
| 1888 | 92.5 | 93.7 | 79.1 | 1892 | 92.9 | 89.0 | 85.6 | 1896 | 96.0 | 93.2 | 86.0 | 1900 | 87.9 | 80.5 | 72.8 |

*Acreage, production, value, and price of buckwheat in the United States, 1866 to 1900, inclusive.*

| Year. | Acreage. | Average yield per acre. | Production. | Average farm price per bushel, Dec. 1. | Farm value, Dec. 1. |
|---|---|---|---|---|---|
| | *Acres.* | *Bushels.* | *Bushels.* | *Cents.* | *Dollars.* |
| 1866 | 1,045,624 | 21.8 | 22,791,839 | 67.6 | 15,413,160 |
| 1867 | 1,227,826 | 17.4 | 21,359,000 | 78.7 | 16,812,070 |
| 1868 | 1,113,993 | 17.8 | 19,863,700 | 78.0 | 15,490,426 |
| 1869 | 1,028,693 | 16.9 | 17,431,100 | 71.9 | 12,534,851 |
| 1870 | 536,992 | 18.3 | 9,841,500 | 70.5 | 6,937,471 |
| 1871 | 413,915 | 20.1 | 8,328,700 | 74.5 | 6,208,165 |
| 1872 | 448,497 | 18.1 | 8,133,500 | 73.5 | 5,979,222 |
| 1873 | 454,152 | 17.3 | 7,837,700 | 75.0 | 5,878,629 |
| 1874 | 452,590 | 17.7 | 8,016,600 | 72.9 | 5,843,645 |
| 1875 | 575,530 | 17.5 | 10,082,100 | 62.0 | 6,254,564 |
| 1876 | 666,441 | 14.5 | 9,668,800 | 66.6 | 6,435,836 |
| 1877 | 649,923 | 15.7 | 10,177,000 | 66.9 | 6,808,180 |
| 1878 | 673,100 | 18.2 | 12,246,820 | 52.6 | 6,441,240 |
| 1879 | 639,900 | 20.5 | 13,140,000 | 59.8 | 7,856,191 |
| 1880 | 822,802 | 17.8 | 14,617,535 | 59.4 | 8,682,488 |
| 1881 | 828,815 | 11.4 | 9,486,200 | 86.5 | 8,205,705 |
| 1882 | 847,112 | 13.0 | 11,019,353 | 73.0 | 8,038,862 |
| 1883 | 857,349 | 8.9 | 7,668,954 | 82.2 | 6,303,980 |
| 1884 | 879,403 | 12.6 | 11,116,000 | 58.9 | 6,549,020 |
| 1885 | 914,394 | 13.8 | 12,626,000 | 55.9 | 7,057,363 |
| 1886 | 917,915 | 12.9 | 11,869,000 | 54.5 | 6,465,120 |
| 1887 | 910,506 | 11.9 | 10,844,000 | 56.5 | 6,122,320 |
| 1888 | 912,630 | 13.2 | 12,050,000 | 63.3 | 7,627,647 |
| 1889 | 837,162 | 14.5 | 12,110,329 | 50.5 | 6,113,119 |
| 1890 | 844,579 | 14.7 | 12,432,831 | 57.4 | 7,132,872 |
| 1891 | 849,364 | 15.0 | 12,760,932 | 57.0 | 7,271,506 |
| 1892 | 861,451 | 14.1 | 12,143,185 | 51.8 | 6,295,643 |
| 1893 | 815,614 | 14.9 | 12,132,311 | 58.4 | 7,074,450 |
| 1894 | 789,232 | 16.1 | 12,668,200 | 55.6 | 7,040,238 |
| 1895 | 763,277 | 20.1 | 15,341,399 | 45.2 | 6,936,325 |
| 1896 | 754,898 | 18.7 | 14,089,783 | 39.2 | 5,522,339 |
| 1897 | 717,836 | 20.9 | 14,997,451 | 42.1 | 6,319,188 |
| 1898 | 678,332 | 17.3 | 11,721,927 | 45.0 | 5,271,462 |
| 1899 | 670,148 | 16.6 | 11,094,473 | 55.7 | 6,183,675 |
| 1900 | 637,930 | 15.0 | 9,566,966 | 55.8 | 5,341,413 |

*Acreage, production, and value of buckwheat in the United States, in 1900, by States.*

| States. | Acreage. | Average yield per acre. | Production. | Average farm price, Dec. 1. | Average value per acre. | Farm value, Dec. 1. |
|---|---|---|---|---|---|---|
| | *Acres.* | *Bushels.* | *Bushels.* | *Cents.* | *Dollars.* | *Dollars.* |
| Maine | 23,992 | 30 | 719,760 | 49 | 14.70 | 352,682 |
| New Hampshire | 2,799 | 22 | 61,578 | 52 | 11.44 | 32,021 |
| Vermont | 9,535 | 25 | 238,375 | 50 | 12.50 | 119,188 |
| Massachusetts | 2,187 | 17 | 37,179 | 72 | 12.24 | 26,769 |
| Connecticut | 3,769 | 16 | 60,304 | 65 | 10.40 | 39,198 |
| New York | 234,297 | 14 | 3,280,158 | 57 | 7.98 | 1,869,690 |
| New Jersey | 10,005 | 16 | 160,080 | 59 | 9.44 | 94,447 |
| Pennsylvania | 227,743 | 14 | 3,188,402 | 55 | 7.70 | 1,753,621 |
| Delaware | 243 | 13 | 3,159 | 52 | 6.76 | 1,643 |
| Maryland | 7,435 | 15 | 111,525 | 57 | 8.55 | 63,569 |
| Virginia | 4,524 | 13 | 58,812 | 55 | 7.15 | 32,347 |
| North Carolina | 1,601 | 13 | 20,813 | 56 | 7.28 | 11,655 |
| Tennessee | 955 | 14 | 13,370 | 59 | 8.26 | 7,888 |
| West Virginia | 13,174 | 17 | 223,958 | 56 | 9.52 | 125,416 |
| Ohio | 9,227 | 16 | 147,632 | 58 | 9.28 | 85,627 |
| Michigan | 22,160 | 14 | 310,240 | 51 | 7.14 | 158,222 |
| Indiana | 5,011 | 14 | 70,154 | 61 | 8.54 | 42,794 |
| Illinois | 4,476 | 15 | 67,140 | 65 | 9.75 | 43,641 |
| Wisconsin | 27,533 | 14 | 385,462 | 59 | 8.26 | 227,423 |

*Average, production, and value of buckwheat in the United States, in 1900, by States*—Cont'd.

| States. | Acreage. | Average yield per acre. | Production. | Average farm price, Dec. 1. | Average value per acre. | Farm value Dec. 1. |
|---|---|---|---|---|---|---|
| | | *Bushels.* | *Bushels.* | *Cents.* | *Dollars.* | *Dollars.* |
| Minnesota | 9,564 | 15 | 143,460 | 57 | 8.55 | 81,772 |
| Iowa | 9,920 | 15 | 148,800 | 64 | 9.60 | 95,232 |
| Missouri | 2,399 | 13 | 31,187 | 69 | 8.97 | 21,519 |
| Nebraska | 5,155 | 16 | 82,480 | 64 | 10.24 | 52,787 |
| Oregon | 226 | 13 | 2,938 | 77 | 10.01 | 2,262 |
| United States | 637,930 | 15.0 | 9,566,966 | 55.8 | 8.37 | 5,341,413 |

*Average yield per acre of buckwheat in the United States, 1891–1900, by States.*

| States. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* |
| Maine | 22.0 | 19.0 | 29.0 | 37.8 | 38.6 | 42.3 | 35.0 | 26.5 | 22.0 | 30.0 |
| New Hampshire | 21.5 | 17.5 | 23.2 | 20.0 | 29.9 | 27.2 | 27.0 | 20.0 | 20.0 | 22.0 |
| Vermont | 22.5 | 20.0 | 29.2 | 22.4 | 34.5 | 31.4 | 24.0 | 21.4 | 23.0 | 25.0 |
| Massachusetts | 16.5 | 11.5 | 27.5 | 18.9 | 15.0 | 18.3 | 19.0 | 20.0 | 20.0 | 17.0 |
| Connecticut | 16.0 | 20.0 | 15.8 | 16.4 | 15.4 | 14.2 | 17.0 | 19.0 | 19.0 | 16.0 |
| New York | 17.5 | 14.7 | 14.4 | 15.5 | 21.4 | 18.8 | 22.0 | 16.8 | 13.0 | 14.0 |
| New Jersey | 14.2 | 12.5 | 14.4 | 14.4 | 18.7 | 20.7 | 16.0 | 21.0 | 21.0 | 16.0 |
| Pennsylvania | 13.6 | 14.5 | 14.1 | 18.0 | 19.9 | 17.3 | 21.0 | 17.2 | 20.0 | 14.0 |
| Delaware | ...... | ...... | 20.0 | 20.0 | 10.0 | 20.0 | 19.0 | 16.5 | 18.0 | 13.0 |
| Maryland | 12.5 | 12.5 | 11.8 | 20.0 | 10.9 | 22.7 | 19.0 | 12.2 | 13.0 | 15.0 |
| Virginia | 12.5 | 8.3 | 13.3 | 14.7 | 10.1 | 18.0 | 14.0 | 17.3 | 14.0 | 13.0 |
| North Carolina | 11.5 | 7.2 | 11.5 | 18.7 | 12.0 | 20.0 | 11.0 | 19.5 | 17.0 | 13.0 |
| Tennessee | | 7.5 | 12.6 | 12.8 | 10.0 | 24.0 | 18.0 | 18.0 | 12.0 | 14.0 |
| West Virginia | 13.5 | 16.3 | 11.5 | 22.6 | 18.8 | 19.5 | 19.0 | 20.5 | 17.0 | 17.0 |
| Ohio | 15.5 | 12.6 | 12.0 | 14.9 | 14.6 | 18.8 | 18.0 | 20.0 | 16.0 | 16.0 |
| Michigan | 14.2 | 13.0 | 13.9 | 12.0 | 17.2 | 15.3 | 17.0 | 14.2 | 11.0 | 14.0 |
| Indiana | 13.2 | 11.5 | 6.9 | 14.8 | 14.3 | 24.0 | 14.0 | 18.4 | 16.0 | 14.0 |
| Illinois | 14.0 | 11.3 | 11.6 | 11.7 | 13.3 | 13.8 | 13.0 | 14.0 | 15.0 | 15.0 |
| Wisconsin | 9.5 | 13.5 | 15.8 | 8.5 | 17.9 | 13.5 | 18.0 | 15.5 | 15.0 | 14.0 |
| Minnesota | 12.5 | 13.8 | 15.2 | 9.2 | 15.3 | 10.6 | 17.0 | 15.0 | 17.0 | 15.0 |
| Iowa | 13.5 | 10.7 | 13.2 | 13.6 | 13.5 | 16.2 | 17.0 | 16.0 | 16.0 | 15.0 |
| Missouri | 12.5 | 11.3 | 12.7 | 9.2 | 10.2 | 21.8 | 15.0 | 15.8 | 14.0 | 13.0 |
| Nebraska | 12.0 | 8.2 | 14.7 | 3.7 | 6.7 | 21.3 | 14.0 | 12.8 | 16.0 | 16.0 |
| Oregon | ...... | 11.2 | 20.0 | 38.0 | 15.5 | 21.0 | 18.0 | 14.0 | 17.0 | 13.0 |
| General average | 15.30 | 14.10 | 14.86 | 16.05 | 20.10 | 18.66 | 20.89 | 17.28 | 16.56 | 15.0 |

*Average value per acre of buckwheat in the United States, 1891–1900, by States.*

| States. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1838. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| Maine | $13.42 | $10.83 | $15.66 | $21.92 | $17.76 | $16.07 | $15.40 | $10.34 | $9.68 | $14.70 |
| New Hampshire | 14.40 | 12.25 | 8.58 | 12.20 | 14.05 | 17.20 | 14.85 | 9.40 | 10.00 | 11.44 |
| Vermont | 12.37 | 9.60 | 15.48 | 12.77 | 12.77 | 12.56 | 11.04 | 9.84 | 11.96 | 12.50 |
| Massachusetts | 11.55 | 8.97 | 20.63 | 12.85 | 8.85 | 9.70 | 12.54 | 12.20 | 14.00 | 12.24 |
| Connecticut | 12.32 | 9.00 | 11.38 | 10.99 | 8.62 | 7.24 | 9.69 | 10.64 | 11.97 | 10.40 |
| New York | 9.80 | 7.35 | 8.64 | 8.37 | 9.42 | 6.96 | 8.80 | 7.56 | 7.67 | 7.98 |
| New Jersey | 9.51 | 7.12 | 9.50 | 9.36 | 9.35 | 8.07 | 7.84 | 11.34 | 11.76 | 9.44 |
| Pennsylvania | 7.75 | 7.69 | 8.32 | 9.54 | 8.76 | 6.57 | 8.82 | 7.57 | 10.80 | 7.70 |
| Delaware | 11.47 | 8.46 | 11.00 | 10.00 | 5.00 | 6.00 | 6.84 | 6.60 | 8.82 | 6.76 |
| Maryland | 8.75 | 8.12 | 6.84 | 11.20 | 6.10 | 11.12 | 9.69 | 6.47 | 7.28 | 8.55 |
| Virginia | 8.12 | 5.06 | 7.31 | 7.94 | 5.45 | 8.46 | 7.00 | 7.79 | 7.56 | 7.15 |
| North Carolina | 6.44 | 3.96 | 5.63 | 8.79 | 5.28 | 12.00 | 5.39 | 9.36 | 8.33 | 7.28 |
| Tennessee | 8.86 | 4.65 | 6.80 | 7.30 | 5.40 | 14.88 | 10.26 | 9.36 | 6.84 | 8.26 |
| West Virginia | 8.10 | 10.60 | 7.82 | 14.01 | 10.72 | 9.75 | 9.31 | 10.05 | 9.52 | 9.52 |
| Ohio | 10.08 | 7.43 | 7.20 | 9.83 | 8.03 | 8.08 | 9.00 | 10.20 | 9.28 | 9.28 |
| Michigan | 7.10 | 6.37 | 7.37 | 6.60 | 7.40 | 5.81 | 6.46 | 5.96 | 6.05 | 7.14 |
| Indiana | 8.32 | 6.67 | 3.86 | 8.29 | 8.29 | 12.24 | 6.86 | 9.38 | 9.44 | 8.54 |
| Illinois | 8.96 | 6.78 | 6.61 | 9.01 | 5.85 | 6.21 | 7.41 | 7.28 | 8.70 | 9.75 |
| Wisconsin | 5.03 | 6.08 | 9.01 | 4.76 | 8.23 | 5.13 | 6.84 | 6.20 | 9.45 | 8.26 |
| Minnesota | 7.00 | 6.21 | 8.06 | 5.43 | 7.80 | 4.35 | 7.65 | 7.35 | 8.84 | 8.55 |
| Iowa | 8.10 | 6.42 | 8.05 | 10.20 | 6.75 | 7.45 | 8.33 | 7.69 | 9.28 | 9.60 |
| Missouri | 9.37 | 7.35 | 7.37 | 5.52 | 5.92 | 15.26 | 9.00 | 9.48 | 8.54 | 8.97 |
| Nebraska | 6.96 | 4.10 | 7.64 | 2.52 | 4.36 | 10.65 | 7.14 | 7.81 | 9.92 | 10.24 |
| Oregon | 12.39 | 8.40 | 10.00 | 20.90 | 7.75 | 14.28 | 9.90 | 8.12 | 12.58 | 10.01 |
| General average | 8.56 | 7.31 | 8.67 | 8.92 | 9.09 | 7.32 | 8.80 | 7.77 | 9.23 | 8.37 |

*Average farm price of buckwheat per bushel in the United States December 1, 1891–1900, by States.*

| States. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| Maine | 61 | 57 | 54 | 58 | 46 | 38 | 44 | 39 | 44 | 49 |
| New Hampshire | 67 | 70 | 37 | 61 | 47 | 63 | 55 | 47 | 50 | 52 |
| Vermont | 55 | 48 | 53 | 57 | 37 | 40 | 46 | 46 | 52 | 50 |
| Massachusetts | 70 | 78 | 75 | 68 | 59 | 53 | 66 | 61 | 70 | 72 |
| Connecticut | 77 | 75 | 72 | 67 | 56 | 51 | 57 | 56 | 63 | 65 |
| New York | 56 | 50 | 60 | 54 | 44 | 37 | 40 | 45 | 59 | 57 |
| New Jersey | 67 | 57 | 66 | 65 | 50 | 39 | 49 | 54 | 56 | 59 |
| Pennsylvania | 57 | 53 | 59 | 53 | 44 | 38 | 42 | 44 | 54 | 55 |
| Delaware | 75 | 60 | 55 | 50 | 50 | 30 | 36 | 40 | 49 | 52 |
| Maryland | 70 | 65 | 58 | 56 | 56 | 49 | 51 | 53 | 56 | 57 |
| Virginia | 65 | 61 | 55 | 54 | 54 | 47 | 50 | 45 | 54 | 55 |
| North Carolina | 56 | 55 | 49 | 47 | 44 | 60 | 49 | 48 | 49 | 56 |
| Tennessee | ...... | 62 | 54 | 57 | 54 | 62 | 57 | 52 | 57 | 59 |
| West Virginia | 60 | 65 | 68 | 62 | 57 | 50 | 49 | 49 | 56 | 56 |
| Ohio | 65 | 59 | 60 | 66 | 55 | 43 | 50 | 51 | 58 | 58 |
| Michigan | 50 | 49 | 53 | 55 | 43 | 38 | 38 | 42 | 55 | 51 |
| Indiana | 63 | 58 | 56 | 56 | 58 | 51 | 49 | 51 | 59 | 61 |
| Illinois | 64 | 60 | 57 | 77 | 44 | 45 | 57 | 52 | 58 | 65 |
| Wisconsin | 53 | 45 | 57 | 56 | 46 | 38 | 38 | 40 | 63 | 59 |
| Minnesota | 56 | 45 | 53 | 59 | 51 | 41 | 45 | 49 | 52 | 57 |
| Iowa | 60 | 60 | 61 | 75 | 50 | 46 | 49 | 48 | 58 | 64 |
| Missouri | 75 | 65 | 58 | 60 | 58 | 70 | 60 | 60 | 61 | 69 |
| Nebraska | 58 | 50 | 52 | 68 | 65 | 50 | 51 | 61 | 62 | 64 |
| Oregon | 81 | 75 | 50 | 55 | 50 | 68 | 55 | 58 | 74 | 77 |
| General average | 56.98 | 51.85 | 58.36 | 55.57 | 45.21 | 39.19 | 42.14 | 44.97 | 55.74 | 55.8 |

## POTATOES.

The potato crop of the United States in 1900 was 210,926,897 bushels, worth on the farm $90,811,167. This was the largest value reached since 1894, although the crop was smaller by nearly 18,000,000 bushels than in 1899. The decrease in yield was more than made up by an advance from 39 cents to 43.1 cents in the farm price. The acreage in 1900 was larger by 29,703 acres than in 1899, but the average yield fell off from 88.6 bushels per acre to 80.8 bushels.

The larger part of the potato crop of this country is produced by the States of New York, Iowa, Pennsylvania, Michigan, Illinois, Ohio, Wisconsin, Nebraska, Minnesota, Missouri, Kansas, and Maine. The New York acreage is usually nearly double that of any other State and the value of the crop is more than one-eighth of the total. The area planted annually in the other States named runs between 100,000 and 200,000 acres. The increased acreage in 1900 was due mainly to an increase of 13,000 acres in New York and 9,000 acres in Pennsylvania. The yield declined in New York from 88 bushels an acre to 81, and in Pennsylvania from 85 bushels to 58, the farm price at the same time advancing from 40 to 45 cents in New York and from 43 to 53 cents in Pennsylvania. Notable changes were made also in Minnesota, where the acreage decreased 7,000 acres, the yield per acre from 96 to 81 bushels, and the price advanced from 25 to 30 cents; in Wisconsin, where the acreage fell off nearly 5,000 acres and the price advanced from 26 to 28 cents; Iowa, where the decrease in acreage was 4,000 acres, in yield from 100 bushels to 72 bushels per acre, and the advance in price from 23 to 37 cents; in Missouri, where the acreage was 3,000 acres greater, the yield increased from 83 to 93 bushels per acre, but the price fell from 40 to 35 cents; in Illinois, where the acreage increased by 3,000 acres, the yield fell from 96 bushels to 92 per acre, and the price was unchanged; in Michigan, where the acreage decreased by 1,500 acres, the yield advanced from 66 to 97 bushels per acre, and the price fell from 32 to 26 cents; and in Nebraska, where the acreage increased 3,000 acres, the yield fell from 94 to 66 bushels per acre, and the price advanced from 25 to 49 cents a bushel.

It will be noted that in no crop is there a larger variation in yield per acre in the important States, running from 66 bushels per acre in Nebraska to 103 bushels in Wisconsin, nor a greater change in the yield in the same State in different years. The farm prices also vary greatly.

The wholesale price in Chicago in 1900 made little change and in other cities did not show such marked variations as are found in the farm prices.

*Condition of the potato crop of the United States, monthly, 1885–1900.*

| Year. | July. | Aug. | Sept. | Oct. | Year. | July. | Aug. | Sept. | Oct. |
|---|---|---|---|---|---|---|---|---|---|
| 1885 | 97.0 | 95.0 | 93.0 | 82.0 | 1893 | 94.8 | 86.0 | 71.8 | 71.2 |
| 1886 | 96.6 | 88.3 | 81.4 | 81.0 | 1894 | 92.3 | 74.0 | 62.4 | 64.3 |
| 1887 | 93.2 | 80.8 | 67.3 | 61.5 | 1895 | 91.5 | 89.7 | 90.8 | 87.4 |
| 1888 | 95.7 | 93.2 | 91.6 | 86.8 | 1896 | 99.0 | 94.8 | 83.2 | 81.7 |
| 1889 | 95.1 | 94.3 | 81.7 | 77.9 | 1897 | 87.8 | 77.9 | 66.7 | 61.6 |
| 1890 | 91.7 | 77.4 | 65.7 | 61.7 | 1898 | 95.5 | 83.9 | 77.7 | 72.5 |
| 1891 | 95.3 | 96.5 | 94.8 | 91.3 | 1899 | 93.8 | 93.0 | 86.3 | 81.7 |
| 1892 | 90.0 | 86.8 | 74.8 | 67.7 | 1900 | 91.3 | 88.2 | 80.0 | 74.4 |

*Acreage, production, value, prices, exports, and imports of potatoes of the United States, 1866 to 1900, inclusive.*

| Year. | Acreage. | Average yield per acre. | Production. | Average farm price per bushel, Dec. 1 | Farm value, Dec. 1. | Chicago price per bushel, Burbank. | | | | Domestic exports, fiscal years beginning July 1. | Imports during fiscal years beginning July 1. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | December. | | May of following year. | | | |
| | | | | | | Low. | High. | Low. | High. | | |
| | *Acres.* | *Bush.* | *Bushels.* | *Cts.* | *Dollars.* | *Cts.* | *Cts.* | *Cts.* | *Cts.* | *Bushels.* | *Bushels.* |
| 1866 | 1,069,381 | 100.2 | 107,200,976 | 47.3 | 50,722,553 | | | | | 512,380 | 198,265 |
| 1867 | 1,192,195 | 82.0 | 97,783,000 | 65.9 | 64,462,486 | | | | | 378,605 | 209,555 |
| 1868 | 1,131,552 | 93.8 | 106,090,000 | 59.3 | 62,918,660 | | | | | 508,249 | 138,470 |
| 1869 | 1,222,250 | 109.5 | 133,886,000 | 42.9 | 57,481,362 | | | | | 596,968 | 75,336 |
| 1870 | 1,325,119 | 86.6 | 114,775,000 | 65.0 | 74,621,019 | | | | | 553,070 | 458,758 |
| 1871 | 1,220,912 | 98.7 | 120,461,700 | 53.9 | 64,905,189 | | | | | 621,537 | 96,259 |
| 1872 | 1,331,331 | 85.3 | 113,516,000 | 53.5 | 60,692,129 | | | | | 515,306 | 346,840 |
| 1873 | 1,295,139 | 81.9 | 106,089,000 | 65.2 | 69,153,709 | | | | | 497,413 | 549,073 |
| 1874 | 1,310,041 | 80.9 | 105,981,000 | 61.5 | 65,223,314 | | | | | 609,642 | 188,757 |
| 1875 | 1,510,041 | 110.5 | 166,877,000 | 34.4 | 57,357,515 | | | | | 704,379 | 92,148 |
| 1876 | 1,741,983 | 71.7 | 124,827,000 | 61.9 | 77,319,541 | | | | | 529,650 | 3,205,555 |
| 1877 | 1,792,287 | 94.9 | 170,092,000 | 43.7 | 74,272,500 | | | | | 744,409 | 528,584 |
| 1878 | 1,776,800 | 69.9 | 124,126,650 | 58.7 | 72,923,575 | | | | | 625,342 | 2,624,149 |
| 1879 | 1,836,800 | 98.9 | 181,626,400 | 43.6 | 79,153,673 | | | | | 696,080 | 721,868 |
| 1880 | 1,842,510 | 91.0 | 167,659,570 | 48.3 | 81,062,214 | | | | | 638,840 | 2,170,372 |
| 1881 | 2,041,670 | 53.5 | 109,145,494 | 91.0 | 99,291,341 | | | | | 408,286 | 8,789,860 |
| 1882 | 2,171,635 | 78.7 | 170,972,508 | 55.7 | 95,304,844 | | | | | 439,443 | 2,362,362 |
| 1883 | 2,289,275 | 90.9 | 208,164,425 | 42.2 | 87,848,991 | | | | | 554,613 | 425,408 |
| 1884 | 2,220,980 | 85.8 | 190,642,000 | 39.6 | 75,524,290 | | | | | 380,868 | 658,633 |
| 1885 | 2,265,823 | 77.2 | 175,029,000 | 44.7 | 78,153,403 | | | 33 | 50 | 494,948 | 1,937,416 |
| 1886 | 2,287,136 | 73.5 | 168,051,000 | 46.7 | 78,441,940 | 44 | 47 | 65 | 90 | 434,864 | 1,432,490 |
| 1887 | 2,357,322 | 56.9 | 134,103,000 | 68.2 | 91,506,740 | 70 | 83 | 65 | 85 | 403,880 | 8,259,538 |
| 1888 | 2,533,280 | 79.9 | 202,365,000 | 40.2 | 81,413,589 | 30 | 37 | 24 | 45 | 471,955 | 883,380 |
| 1889 | 2,647,989 | 77.4 | 204,990,345 | 35.5 | 72,704,413 | 33 | 45 | 30 | 60 | 406,618 | 3,415,578 |
| 1890 | 2,651,579 | 55.8 | 148,078,945 | 75.8 | 112,205,235 | 82 | 93 | 95 | 110 | 341,189 | 5,401,912 |
| 1891 | 2,714,770 | 93.7 | 254,426,971 | 35.8 | 91,024,521 | 30 | 40 | 30 | 50 | 557,022 | 186,871 |
| 1892 | 2,547,962 | 61.5 | 156,654,819 | 66.1 | 103,567,520 | 60 | 72 | 70 | 98 | 845,720 | 4,317,021 |
| 1893 | 2,605,186 | 70.3 | 183,034,203 | 59.4 | 108,661,801 | 51 | 60 | 64 | 88 | 803,111 | 3,002,578 |
| 1894 | 2,737,973 | 62.4 | 170,787,338 | 53.6 | 91,526,787 | 43 | 58 | 40 | 70 | 572,957 | 1,341,533 |
| 1895 | 2,954,952 | 100.6 | 297,237,370 | 26.6 | 78,984,901 | 18 | 24 | 10 | 23 | 680,049 | 175,240 |
| 1896 | 2,767,465 | 91.1 | 252,234,540 | 28.6 | 72,182,350 | 18 | 26 | 19 | 26 | 926,646 | 246,178 |
| 1897 | 2,534,577 | 64.7 | 164,015,964 | 54.7 | 89,643,059 | 50 | 62 | 60 | 87 | 605,187 | 1,171,378 |
| 1898 | 2,557,729 | 75.2 | 192,306,338 | 41.4 | 79,574,772 | 30 | 36 | | | 579,833 | 530,420 |
| 1899 | 2,581,353 | 88.6 | 228,783,232 | 39.0 | 89,328,832 | | | | | 803,360 | 155,413 |
| 1900 | 2,611,054 | 80.8 | 210,926,897 | 43.1 | 90,811,167 | | | | | | |

*Acreage, production, and value of potatoes in the United States in 1900, by States.*

| States and Territories. | Acreage. | Average yield per acre. | Production. | Average farm price, Dec. 1. | Average value per acre. | Farm value, Dec. 1. |
|---|---|---|---|---|---|---|
| | *Acres.* | *Bushels.* | *Bushels.* | *Cents.* | *Dollars.* | *Dollars.* |
| Maine | 49,208 | 126 | 6,200,208 | 49 | 61.74 | 3,038,102 |
| New Hampshire | 17,916 | 101 | 1,809,516 | 53 | 53.53 | 959,043 |
| Vermont | 24,666 | 134 | 3,305,244 | 40 | 53.60 | 1,322,098 |
| Massachusetts | 28,626 | 79 | 2,261,454 | 66 | 52.14 | 1,492,560 |
| Rhode Island | 7,428 | 94 | 698,232 | 70 | 65.80 | 488,762 |
| Connecticut | 25,818 | 96 | 2,478,528 | 70 | 67.20 | 1,734,970 |
| New York | 339,276 | 81 | 27,481,356 | 45 | 36.45 | 12,366,610 |
| New Jersey | 48,435 | 69 | 3,342,015 | 60 | 41.40 | 2,005,209 |

*Acreage, production, and value of potatoes in the United States in 1900, by States*—Cont'd.

| States and Territories. | Acreage. | Average yield per acre. | Production. | Average farm price, Dec. 1. | Average value per acre. | Farm value, Dec. 1. |
|---|---|---|---|---|---|---|
| | *Acres.* | *Bushels.* | *Bushels.* | *Cents.* | *Dollars.* | *Dollars.* |
| Pennsylvania | 188,306 | 58 | 10,921,748 | 53 | 30.74 | 5,788,526 |
| Delaware | 5,344 | 48 | 256,512 | 60 | 28.80 | 153,907 |
| Maryland | 23,081 | 55 | 1,269,455 | 54 | 29.70 | 685,506 |
| Virginia | 38,341 | 58 | 2,223,778 | 59 | 34.22 | 1,312,029 |
| North Carolina | 17,434 | 61 | 1,063,474 | 65 | 39.65 | 691,258 |
| South Carolina | 4,307 | 78 | 335,946 | 100 | 78.00 | 335,946 |
| Georgia | 5,762 | 68 | 391,816 | 77 | 52.36 | 301,698 |
| Florida | 1,738 | 60 | 104,280 | 106 | 63.60 | 110,537 |
| Alabama | 6,057 | 69 | 417,933 | 82 | 56.58 | 342,705 |
| Mississippi | 5,259 | 66 | 347,094 | 83 | 54.78 | 288,088 |
| Louisiana | 7,709 | 70 | 539,630 | 79 | 55.30 | 426,308 |
| Texas | 14,789 | 62 | 916,918 | 88 | 54.56 | 806,888 |
| Arkansas | 29,553 | 72 | 2,127,816 | 57 | 41.04 | 1,212,855 |
| Tennessee | 25,290 | 54 | 1,365,660 | 58 | 31.32 | 792,083 |
| West Virginia | 37,864 | 80 | 3,029,120 | 51 | 40.80 | 1,544,851 |
| Kentucky | 40,107 | 70 | 2,807,490 | 50 | 35.00 | 1,403,745 |
| Ohio | 165,284 | 76 | 12,561,584 | 40 | 30.40 | 5,024,634 |
| Michigan | 171,453 | 97 | 16,630,941 | 26 | 25.22 | 4,324,045 |
| Indiana | 109,163 | 83 | 9,060,529 | 38 | 31.54 | 3,443,001 |
| Illinois | 166,262 | 92 | 15,296,104 | 41 | 37.72 | 6,271,403 |
| Wisconsin | 151,647 | 103 | 15,619,641 | 28 | 28.84 | 4,373,499 |
| Minnesota | 106,618 | 81 | 8,636,058 | 30 | 24.30 | 2,590,817 |
| Iowa | 194,508 | 72 | 14,004,576 | 37 | 26.64 | 5,181,693 |
| Missouri | 108,677 | 93 | 10,106,961 | 35 | 32.55 | 3,537,436 |
| Kansas | 100,642 | 72 | 7,246,224 | 48 | 34.56 | 3,478,188 |
| Nebraska | 146,431 | 66 | 9,664,446 | 49 | 32.34 | 4,735,579 |
| South Dakota | 55,217 | 73 | 4,030,841 | 36 | 26.28 | 1,451,103 |
| North Dakota | 29,555 | 52 | 1,536,860 | 49 | 25.48 | 753,061 |
| Montana | 4,781 | 134 | 640,654 | 53 | 71.02 | 339,547 |
| Wyoming | 3,921 | 99 | 388,179 | 68 | 67.32 | 263,962 |
| Colorado | 33,273 | 56 | 1,863,288 | 82 | 45.92 | 1,527,896 |
| New Mexico | 976 | 19 | 18,544 | 114 | 21.66 | 21,140 |
| Utah | 5,500 | 118 | 649,000 | 48 | 56.64 | 311,520 |
| Nevada | 1,753 | 156 | 273,468 | 56 | 87.36 | 153,142 |
| Idaho | 5,030 | 136 | 684,080 | 47 | 63.92 | 321,518 |
| Washington | 15,859 | 116 | 1,839,644 | 47 | 54.52 | 864,633 |
| Oregon | 15,382 | 110 | 1,692,020 | 45 | 49.50 | 761,409 |
| California | 26,808 | 104 | 2,788,032 | 53 | 55.12 | 1,477,657 |
| United States | 2,611,054 | 80.8 | 210,926,897 | 43.1 | 34.78 | 90,811,167 |

*Average yield per acre of potatoes in the United States, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* |
| Maine | 125 | 82 | 120 | 147 | 163 | 165 | 59 | 130 | 139 | 126 |
| New Hampshire | 110 | 80 | 119 | 120 | 134 | 108 | 51 | 90 | 127 | 101 |
| Vermont | 120 | 54 | 111 | 124 | 154 | 128 | 70 | 105 | 132 | 134 |
| Massachusetts | 120 | 83 | 119 | 105 | 133 | 108 | 62 | 97 | 134 | 79 |
| Rhode Island | 120 | 95 | 108 | 133 | 138 | 105 | 110 | 123 | 142 | 94 |
| Connecticut | 92 | 82 | 87 | 79 | 128 | 106 | 54 | 100 | 130 | 96 |
| New York | 87 | 63 | 70 | 77 | 122 | 89 | 62 | 73 | 88 | 81 |
| New Jersey | 98 | 71 | 73 | 60 | 94 | 94 | 68 | 75 | 83 | 69 |
| Pennsylvania | 84 | 60 | 76 | 64 | 111 | 109 | 63 | 54 | 85 | 58 |
| Delaware | 76 | 42 | 50 | 50 | 58 | 78 | 60 | 49 | 52 | 48 |
| Maryland | 78 | 60 | 49 | 52 | 87 | 90 | 74 | 58 | 64 | 55 |
| Virginia | 76 | 58 | 74 | 59 | 73 | 93 | 61 | 68 | 66 | 58 |
| North Carolina | 75 | 55 | 97 | 62 | 79 | 79 | 66 | 67 | 57 | 61 |
| South Carolina | 69 | 70 | 83 | 59 | 90 | 52 | 65 | 65 | 56 | 78 |
| Georgia | 74 | 70 | 74 | 52 | 58 | 55 | 52 | 54 | 46 | 68 |
| Florida | 74 | 65 | 87 | 90 | 55 | 75 | 75 | 64 | 69 | 60 |
| Alabama | 67 | 65 | 83 | 43 | 70 | 64 | 55 | 74 | 56 | 69 |
| Mississippi | 60 | 67 | 81 | 72 | 58 | 70 | 59 | 74 | 61 | 66 |
| Louisiana | 73 | 65 | 67 | 45 | 89 | 55 | 64 | 78 | 60 | 70 |
| Texas | 69 | 61 | 53 | 80 | 89 | 52 | 60 | 78 | 64 | 62 |
| Arkansas | 75 | 68 | 88 | 82 | 70 | 59 | 55 | 74 | 63 | 72 |
| Tennessee | 70 | 67 | 68 | 55 | 64 | 62 | 40 | 52 | 44 | 54 |
| West Virginia | 88 | 60 | 80 | 52 | 69 | 93 | 56 | 62 | 72 | 80 |
| Kentucky | 78 | 58 | 68 | 54 | 86 | 85 | 47 | 64 | 51 | 70 |
| Ohio | 98 | 60 | 58 | 63 | 63 | 89 | 42 | 61 | 71 | 76 |
| Michigan | 96 | 62 | 75 | 62 | 101 | 88 | 72 | 79 | 66 | 97 |
| Indiana | 93 | 56 | 51 | 59 | 66 | 85 | 31 | 71 | 76 | 83 |
| Illinois | 92 | 52 | 53 | 50 | 77 | 97 | 38 | 70 | 96 | 92 |
| Wisconsin | 98 | 65 | 77 | 45 | 107 | 78 | 99 | 98 | 103 | 103 |

*Average yield per acre of potatoes in the United States, 1891–1901, by States*—Continued.

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* | *Bush.* |
| Minnesota | 100 | 70 | 66 | 39 | 158 | 84 | 106 | 85 | 96 | 81 |
| Iowa | 99 | 51 | 58 | 43 | 106 | 94 | 60 | 80 | 100 | 72 |
| Missouri | 96 | 51 | 78 | 69 | 109 | 78 | 42 | 66 | 83 | 93 |
| Kansas | 88 | 47 | 44 | 41 | 72 | 69 | 48 | 70 | 95 | 72 |
| Nebraska | 97 | 48 | 44 | 22 | 67 | 90 | 69 | 65 | 94 | 66 |
| South Dakota | 91 | 64 | 54 | 23 | 66 | 96 | 94 | 72 | 78 | 73 |
| North Dakota | 105 | 75 | 69 | 84 | 128 | 102 | 99 | 87 | 103 | 52 |
| Montana | 120 | 100 | 138 | 111 | 53 | 170 | 156 | 104 | 141 | 134 |
| Wyoming | 100 | 100 | 134 | 150 | 100 | 167 | 150 | 120 | 125 | 99 |
| Colorado | 115 | 99 | 94 | 85 | 95 | 88 | 97 | 77 | 84 | 56 |
| New Mexico | 85 | 35 | 70 | 75 | 80 | 72 | 90 | 58 | 49 | 19 |
| Utah | 105 | 59 | 88 | 135 | 172 | 155 | 148 | 135 | 120 | 118 |
| Nevada | 98 | 100 | 132 | 161 | 150 | 190 | 135 | 155 | 102 | 156 |
| Idaho | 115 | 98 | 153 | 178 | 105 | 162 | 140 | 120 | 124 | 136 |
| Washington | 125 | 100 | 120 | 125 | 149 | 125 | 162 | 108 | 144 | 116 |
| Oregon | 110 | 70 | 127 | 112 | 64 | 87 | 160 | 86 | 115 | 110 |
| California | 95 | 75 | 96 | 52 | 75 | 80 | 105 | 95 | 119 | 104 |
| General average | 93.90 | 62.00 | 70.26 | 62.38 | 100.59 | 91.14 | 64.71 | 75.19 | 88.63 | 80.8 |

*Average value per acre of potatoes in the United States, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| Maine | $51.25 | $63.14 | $64.80 | $64.68 | $55.42 | $62.70 | $52.51 | $59.80 | $58.38 | $61.74 |
| New Hampshire | 49.50 | 68.00 | 74.97 | 56.40 | 42.88 | 50.76 | 45.90 | 44.10 | 58.42 | 53.53 |
| Vermont | 45.60 | 36.72 | 53.28 | 54.56 | 40.04 | 37.12 | 49.00 | 44.10 | 47.52 | 53.60 |
| Massachusetts | 64.80 | 68.89 | 90.44 | 68.25 | 63.84 | 61.56 | 55.80 | 61.11 | 76.38 | 52.14 |
| Rhode Island | 72.00 | 80.75 | 85.32 | 95.76 | 62.10 | 56.70 | 106.70 | 78.72 | 71.00 | 65.80 |
| Connecticut | 50.60 | 62.32 | 65.25 | 53.72 | 52.48 | 48.76 | 48.60 | 55.00 | 59.80 | 67.20 |
| New York | 32.19 | 40.95 | 38.50 | 36.96 | 28.06 | 27.59 | 41.54 | 30.66 | 35.20 | 36.45 |
| New Jersey | 48.02 | 53.25 | 54.75 | 37.20 | 31.96 | 33.84 | 53.04 | 45.75 | 42.33 | 41.40 |
| Pennsylvania | 36.12 | 43.20 | 45.60 | 36.48 | 31.08 | 29.43 | 41.58 | 31.32 | 36.55 | 30.74 |
| Delaware | 34.20 | 26.46 | 32.50 | 25.00 | 22.04 | 27.30 | 39.00 | 33.81 | 26.52 | 28.80 |
| Maryland | 37.44 | 40.80 | 33.32 | 27.56 | 26.10 | 27.00 | 50.32 | 30.74 | 32.64 | 29.70 |
| Virginia | 35.72 | 34.80 | 47.88 | 33.04 | 27.74 | 31.62 | 42.70 | 37.40 | 36.96 | 34.22 |
| North Carolina | 51.00 | 33.55 | 58.20 | 37.20 | 43.45 | 33.97 | 42.24 | 41.54 | 37.62 | 39.65 |
| South Carolina | 56.58 | 59.50 | 63.91 | 45.43 | 65.70 | 34.32 | 68.25 | 65.00 | 58.24 | 78.00 |
| Georgia | 59.20 | 56.00 | 68.08 | 42.12 | 41.18 | 41.25 | 52.00 | 40.50 | 38.18 | 52.36 |
| Florida | 66.60 | 48.75 | 101.79 | 67.50 | 55.00 | 63.00 | 90.00 | 76.80 | 85.56 | 63.60 |
| Alabama | 52.26 | 49.40 | 73.04 | 37.84 | 56.70 | 48.00 | 51.70 | 61.42 | 48.72 | 56.58 |
| Mississippi | 48.60 | 50.92 | 68.04 | 59.04 | 37.12 | 43.40 | 48.38 | 53.28 | 62.22 | 54.78 |
| Louisiana | 59.86 | 50.05 | 55.61 | 37.35 | 64.08 | 41.80 | 54.40 | 58.50 | 48.60 | 55.30 |
| Texas | 65.55 | 51.85 | 54.59 | 79.20 | 69.42 | 40.56 | 57.00 | 67.08 | 58.24 | 54.56 |
| Arkansas | 48.01 | 47.60 | 56.32 | 43.46 | 35.70 | 31.27 | 46.20 | 40.70 | 44.73 | 41.04 |
| Tennessee | 38.50 | 32.16 | 33.32 | 26.95 | 25.60 | 24.80 | 29.20 | 29.64 | 28.60 | 31.32 |
| West Virginia | 36.96 | 34.80 | 47.20 | 29.64 | 28.98 | 28.83 | 36.40 | 33.48 | 37.44 | 40.80 |
| Kentucky | 35.10 | 30.16 | 38.08 | 30.24 | 33.54 | 28.05 | 31.49 | 29.44 | 31.11 | 35.00 |
| Ohio | 34.30 | 38.40 | 38.86 | 32.76 | 20.16 | 23.14 | 26.04 | 25.01 | 30.53 | 30.40 |
| Michigan | 23.04 | 32.86 | 33.75 | 26.66 | 16.16 | 16.72 | 30.96 | 21.33 | 21.12 | 25.22 |
| Indiana | 34.41 | 40.32 | 37.23 | 31.86 | 20.46 | 21.25 | 19.22 | 29.11 | 32.68 | 31.54 |
| Illinois | 36.80 | 41.60 | 39.22 | 32.00 | 23.10 | 25.22 | 23.56 | 32.20 | 39.36 | 37.72 |
| Wisconsin | 25.48 | 35.10 | 37.73 | 23.85 | 18.19 | 14.82 | 37.62 | 23.52 | 26.78 | 28.84 |
| Minnesota | 24.00 | 33.60 | 30.36 | 19.89 | 22.12 | 17.64 | 32.86 | 21.25 | 24.00 | 24.30 |
| Iowa | 21.78 | 38.25 | 37.70 | 29.67 | 20.14 | 20.68 | 28.20 | 24.00 | 23.00 | 26.64 |
| Missouri | 33.50 | 39.27 | 44.46 | 35.88 | 27.25 | 24.18 | 26.46 | 29.04 | 33.20 | 32.55 |
| Kansas | 30.80 | 41.36 | 34.76 | 27.88 | 30.24 | 18.63 | 26.40 | 35.70 | 42.75 | 34.56 |
| Nebraska | 27.16 | 36.00 | 34.76 | 16.94 | 20.10 | 22.50 | 31.74 | 24.05 | 23.50 | 32.34 |
| South Dakota | 25.48 | 35.20 | 31.86 | 17.02 | 17.16 | 19.20 | 30.08 | 20.16 | 21.06 | 26.28 |
| North Dakota | 21.00 | 30.00 | 33.81 | 38.64 | 21.76 | 21.42 | 32.67 | 29.58 | 27.81 | 25.48 |
| Montana | 49.20 | 60.00 | 95.22 | 53.28 | 25.44 | 54.40 | 62.40 | 57.20 | 74.73 | 71.02 |
| Wyoming | 43.00 | 70.00 | 87.10 | 90.00 | 56.00 | 71.81 | 82.50 | 78.00 | 76.25 | 67.32 |
| Colorado | 32.20 | 60.39 | 50.76 | 46.75 | 31.35 | 41.36 | 54.32 | 41.58 | 46.20 | 45.92 |
| New Mexico | 53.55 | 28.00 | 46.90 | 60.00 | 50.40 | 48.96 | 70.20 | 45.24 | 33.32 | 21.66 |
| Utah | 26.25 | 42.48 | 29.04 | 40.50 | 58.48 | 49.60 | 44.40 | 41.85 | 66.00 | 56.64 |
| Nevada | 49.00 | 58.00 | 52.80 | 56.35 | 57.00 | 72.20 | 98.55 | 139.50 | 91.80 | 87.36 |
| Idaho | 46.00 | 52.92 | 85.68 | 94.34 | 42.00 | 48.60 | 44.80 | 64.80 | 75.64 | 63.92 |
| Washington | 47.50 | 50.00 | 46.80 | 35.00 | 41.72 | 50.00 | 45.36 | 42.14 | 72.00 | 54.52 |
| Oregon | 44.00 | 39.20 | 59.69 | 40.32 | 24.96 | 33.93 | 64.00 | 40.42 | 56.35 | 49.50 |
| California | 51.31 | 44.25 | 48.00 | 25.48 | 36.00 | 42.40 | 51.45 | 52.25 | 74.97 | 55.12 |
| General average | 33.53 | 40.65 | 41.71 | 33.43 | 26.73 | 26.08 | 35.37 | 31.11 | 34.60 | 34.78 |

*Average farm price of potatoes per bushel in the United States December 1, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| Maine | 41 | 77 | 54 | 44 | 34 | 38 | 89 | 46 | 42 | 49 |
| New Hampshire | 45 | 85 | 63 | 47 | 32 | 47 | 90 | 49 | 46 | 53 |
| Vermont | 38 | 68 | 48 | 44 | 26 | 29 | 70 | 42 | 36 | 40 |
| Massachusetts | 54 | 83 | 76 | 65 | 48 | 57 | 90 | 63 | 57 | 66 |
| Rhode Island | 60 | 85 | 79 | 72 | 45 | 54 | 97 | 64 | 50 | 70 |
| Connecticut | 55 | 76 | 75 | 68 | 41 | 46 | 90 | 55 | 46 | 70 |
| New York | 37 | 65 | 55 | 48 | 23 | 31 | 67 | 42 | 40 | 45 |
| New Jersey | 49 | 75 | 75 | 62 | 34 | 36 | 78 | 61 | 51 | 60 |
| Pennsylvania | 43 | 72 | 60 | 57 | 28 | 27 | 66 | 58 | 43 | 53 |
| Delaware | 45 | 63 | 65 | 50 | 33 | 35 | 65 | 69 | 51 | 60 |
| Maryland | 48 | 68 | 68 | 53 | 30 | 30 | 68 | 53 | 51 | 54 |
| Virginia | 47 | 60 | 57 | 56 | 38 | 34 | 70 | 55 | 56 | 59 |
| North Carolina | 68 | 61 | 60 | 60 | 55 | 43 | 64 | 62 | 66 | 65 |
| South Carolina | 82 | 85 | 77 | 77 | 73 | 66 | 105 | 100 | 104 | 100 |
| Georgia | 80 | 80 | 92 | 81 | 71 | 75 | 100 | 75 | 83 | 77 |
| Florida | 90 | 75 | 117 | 75 | 100 | 84 | 120 | 120 | 124 | 106 |
| Alabama | 78 | 76 | 88 | 88 | 81 | 75 | 94 | 83 | 87 | 82 |
| Mississippi | 81 | 76 | 84 | 82 | 64 | 62 | 82 | 72 | 102 | 83 |
| Louisiana | 82 | 77 | 83 | 83 | 72 | 76 | 85 | 75 | 81 | 79 |
| Texas | 95 | 85 | 103 | 99 | 78 | 78 | 95 | 86 | 91 | 88 |
| Arkansas | 64 | 70 | 64 | 53 | 51 | 53 | 84 | 55 | 71 | 57 |
| Tennessee | 55 | 48 | 49 | 49 | 40 | 40 | 73 | 57 | 65 | 58 |
| West Virginia | 42 | 58 | 59 | 57 | 42 | 31 | 65 | 54 | 52 | 51 |
| Kentucky | 45 | 52 | 56 | 56 | 39 | 33 | 67 | 46 | 61 | 50 |
| Ohio | 35 | 64 | 67 | 52 | 32 | 26 | 62 | 41 | 43 | 40 |
| Michigan | 24 | 53 | 45 | 43 | 16 | 19 | 43 | 27 | 32 | 26 |
| Indiana | 37 | 72 | 73 | 54 | 31 | 25 | 62 | 41 | 43 | 38 |
| Illinois | 40 | 80 | 74 | 64 | 30 | 26 | 62 | 46 | 41 | 41 |
| Wisconsin | 26 | 54 | 49 | 53 | 17 | 19 | 38 | 24 | 26 | 28 |
| Minnesota | 24 | 48 | 46 | 51 | 14 | 21 | 31 | 25 | 25 | 30 |
| Iowa | 22 | 75 | 65 | 69 | 19 | 22 | 47 | 30 | 23 | 37 |
| Missouri | 35 | 77 | 57 | 52 | 25 | 31 | 63 | 44 | 40 | 35 |
| Kansas | 35 | 88 | 79 | 68 | 42 | 27 | 55 | 51 | 45 | 48 |
| Nebraska | 28 | 75 | 79 | 77 | 30 | 25 | 46 | 37 | 25 | 49 |
| South Dakota | 28 | 55 | 59 | 74 | 26 | 20 | 32 | 28 | 27 | 36 |
| North Dakota | 20 | 40 | 49 | 46 | 17 | 21 | 33 | 34 | 27 | 49 |
| Montana | 41 | 60 | 69 | 48 | 48 | 32 | 40 | 55 | 53 | 53 |
| Wyoming | 43 | 70 | 65 | 60 | 56 | 43 | 55 | 65 | 61 | 68 |
| Colorado | 28 | 61 | 54 | 55 | 33 | 47 | 56 | 54 | 55 | 82 |
| New Mexico | 63 | 80 | 67 | 80 | 63 | 68 | 78 | 78 | 68 | 114 |
| Utah | 25 | 72 | 33 | 30 | 34 | 32 | 30 | 31 | 55 | 48 |
| Nevada | 50 | 58 | 40 | 35 | 38 | 38 | 73 | 90 | 90 | 56 |
| Idaho | 40 | 54 | 56 | 53 | 40 | 30 | 32 | 54 | 61 | 47 |
| Washington | 38 | 50 | 39 | 28 | 28 | 40 | 28 | 39 | 50 | 47 |
| Oregon | 40 | 56 | 47 | 36 | 39 | 39 | 40 | 47 | 49 | 45 |
| California | 54 | 59 | 50 | 49 | 48 | 53 | 49 | 55 | 63 | 53 |
| General average | 35.78 | 66.11 | 59.37 | 53.59 | 26.57 | 28.62 | 54.66 | 41.38 | 39.04 | 43.1 |

*Wholesale prices of potatoes per bushel in leading cities of the United States, 1896–1900.*

| Date. | Cincinnati. | | Chicago. | | Milwaukee. | | St. Louis. | |
|---|---|---|---|---|---|---|---|---|
| | Per barrel. | | Burbank, per bushel. | | Per bushel. | | Burbank, per bushel. | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | | | | | | | | |
| January | \$1.25 | \$1.30 | \$0.18 | \$0.24 | \$0.15 | \$0.25 | \$0.22 | \$0.27½ |
| February | .95 | 1.10 | .18 | .23 | .15 | .25 | .22 | .27 |
| March | .80 | 1.10 | .16 | .21 | .12 | .25 | .20 | .24 |
| April | .70 | .95 | .16 | .22 | .12 | .22 | .20 | .27 |
| May | .60 | .80 | .10 | .23 | .10 | .22 | .23 | .30 |
| June | .70 | 1.35 | .10 | .29 | .10 | .25 | .20 | .45 |
| July | .75 | 1.25 | ........ | ........ | .10 | .35 | .20 | .20 |
| August | .75 | .90 | ........ | ........ | .23 | .30 | ........ | ........ |
| September | .75 | 1.00 | .21 | .31 | .23 | .35 | ........ | ........ |
| October | .75 | 1.10 | .18 | .25 | .18 | .30 | .27 | .35 |
| November | .75 | 1.00 | .18 | .26 | .18 | .25 | .21 | .32½ |
| December | .90 | 1.00 | .18 | .26 | .18 | .25 | .27 | .30 |
| **1897.** | | | | | | | | |
| January | .90 | 1.10 | .18 | .27 | .18 | .25 | .24 | .32 |
| February | ........ | ........ | .21 | .26 | .18 | .25 | .25 | .30 |
| March | ........ | ........ | .18 | .25 | .20 | .25 | .21 | .30 |
| April | ........ | ........ | .18 | .25 | .15 | .25 | .23 | .30 |

*Wholesale prices of potatoes per bushel in leading cities of the United States, 1896-1900*—Continued.

| Date. | Cincinnati. | | Chicago. | | Milwaukee. | | St. Louis. | |
|---|---|---|---|---|---|---|---|---|
| | Per barrel. | | Burbank, per bushel. | | Per bushel. | | Burbank, per bushel. | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1897.** | | | | | | | | |
| May | $1.00 | $4.75 | $0.19 | $0.20 | $0.15 | $0.25 | $0.24 | $0.28 |
| June | 2.25 | 3.00 | .18 | .38 | .15 | 1.00 | .27 | .40 |
| July | 1.75 | 2.50 | .23 | .28 | .20 | 1.00 | ....... | ....... |
| August | 1.75 | 2.50 | ....... | ....... | .50 | .70 | .55 | .58 |
| September | 1.85 | 2.35 | .52 | .58 | .35 | .50 | .50 | .65 |
| October | 1.50 | 2.00 | .38 | .52 | .35 | .45 | .40 | .60 |
| November | 1.75 | 2.25 | .40 | .55 | .35 | .55 | .37 | .53 |
| December | 2.00 | 2.50 | .50 | .62 | .45 | .55 | .53½ | .65 |
| **1898.** | | | | | | | | |
| January | 2.00 | 2.25 | .57 | .62 | .45 | .55 | .60 | .68 |
| February | ....... | ....... | .57 | .64 | .50 | .60 | .62 | .68 |
| March | ....... | ....... | .60 | .67 | .50 | .60 | .58 | .70 |
| April | ....... | ....... | .58 | .66 | .45 | .75 | .52½ | .75 |
| May | 2.80 | 3.75 | .60 | .87 | .50 | .90 | .60 | .85 |
| June | 2.25 | 2.75 | .32 | .65 | .35 | .65 | .55 | .70 |
| July | 1.50 | 2.50 | .44 | .50 | .35 | .80 | .40 | .50 |
| August | 1.25 | 1.75 | ....... | ....... | .35 | .50 | ....... | ....... |
| September | 1.25 | 1.75 | .32 | .48 | .30 | .40 | .35 | .50 |
| October | 1.25 | 1.60 | .29 | .36 | .25 | .35 | .35 | .43 |
| November | 1.25 | 1.35 | .29 | .35 | .25 | .30 | .30 | .41 |
| December | ....... | ....... | .30 | .36 | .25 | .30 | .33 | .40 |
| **1899.** | | | | | | | | |
| January | ....... | ....... | .34 | .38 | .20 | .35 | .39½ | .45 |
| February | ....... | ....... | .34 | .50 | .20 | .45 | .42 | .55 |
| March | ....... | ....... | .48 | .75 | .30 | .65 | .53 | .75 |
| April | ....... | ....... | .49 | .68 | .40 | .60 | .56 | .72 |
| May | 2.00 | 6.00 | .33 | .52 | .20 | .55 | .40 | .55 |
| June | 1.50 | 2.50 | .34 | .60 | .15 | .40 | .42 | .52 |
| July | 1.15 | 2.00 | .28 | .28 | .20 | .90 | ....... | ....... |
| August | 1.10 | 1.50 | ....... | ....... | .20 | .35 | .25 | .30 |
| September | 1.40 | 1.60 | .30 | .40 | .20 | .30 | .32 | .40 |
| October | ....... | ....... | .26 | .32 | .18 | .30 | .32 | .40 |
| November | ....... | ....... | .31 | .42 | .18 | .35 | .33 | .44 |
| December | ....... | ....... | .35 | .46 | .25 | .40 | .43 | .48 |
| **1900.** | Per bushel. | | | | | | | |
| January | .45 | .57 | .42 | .50 | .25 | .40 | .43 | .52 |
| February | .45 | .55 | .40 | .49 | .25 | .42 | .43 | .50 |
| March | .43 | .50 | .33 | .45 | .25 | .45 | .35 | .46 |
| April | .32 | .45 | .26 | .37 | .20 | .38 | .27 | .40 |
| May | .33 | .50 | .27 | .39 | .20 | .35 | .30 | .45 |
| June | .35 | .50 | .31 | .41 | .20 | .80 | .36 | .45 |
| July | ....... | ....... | ....... | ....... | .20 | .55 | ....... | ....... |
| August | ....... | ....... | ....... | ....... | .30 | .40 | ....... | ....... |
| September | .40 | .45 | .30 | .40 | .28 | .38 | .32 | .40 |
| October | .32 | .40 | .25 | .34 | .23 | .35 | .32 | .38 |
| November | .38 | .47 | .29 | .46 | .23 | .42 | .33 | .48 |
| December | .40 | .50 | .40 | .48 | .30 | .50 | .45 | .54 |

## HAY.

The hay crop of 1900 was short because of a decreased acreage combined with a lower average yield per acre. There was an advance in price which gave a total value $33,000,000 greater than in 1899 and $47,000,000 greater than in 1898. The area harvested was 39,132,890 acres, more than 2,000,000 less than in 1899, which was the smallest since 1888. The yield was 50,110,906 tons, the lowest with the exception of 1895 since 1888. The farm price was the highest since 1887, while the Chicago price was exceeded only once in that time; that was in 1891.

The reduction in acreage was made up principally of 120,000 acres in New York, the leading hay State in the Union, 225,000 in Iowa, 230,000 acres in Kansas, 125,000 in Pennsylvania, 112,000 in Missouri, 122,000 in Nebraska, 165,000 in Illinois, 82,000 in Ohio, 188,000 in Indiana, 287,000 in Minnesota, 265,000 in Wisconsin, and 194,000 in South Dakota. There were increases of 88,000 acres in Washington, 76,000 in Oregon, and 85,000 in California, with a consequent increased production and a practically stationary price.

There was a decrease in area of 6,000 acres in Texas but an increase in yield per acre of 740 pounds. This is the more noticeable as the highest point reached in an upward trend in yield for the past ten years. The yield in 1892 averaged 2,100 pounds per acre against 3,600 in 1900, and the value per acre $8.96 against $12.24 in 1900. Similar advances in yield and value are noted for Washington and Oregon.

There has been a nearly steady increase of exports of hay from this country for twenty years, an occasional decrease being explained by a heavy world's crop the previous year or other unusual conditions.

Wholesale prices declined notably in the summer of 1896 and continued low until last year, when the 1896 figures were restored and a little increased.

*Acreage, production, value, prices, and exports of hay of the United States, 1866 to 1900, inclusive.*

| Year. | Acreage. | Average yield per acre. | Production. | Average farm price per ton Dec. 1. | Farm value Dec. 1. | Chicago prices of No. 1 timothy by carload lots. December. Low. | December. High. | May of following year. Low. | May of following year. High. | Domestic exports, fiscal years beginning July 1. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Acres.* | *Tons.* | *Tons.* | *Dolls.* | *Dollars.* | *Dolls.* | *Dolls.* | *Dolls.* | *Dolls.* | *Tons.* |
| 1866 | 17,668,904 | 1.23 | 21,778,627 | 10.14 | 220,835,771 | | | | | 5,028 |
| 1867 | 20,020,554 | 1.31 | 26,277,000 | 10.21 | 268,300,623 | | | | | 5,645 |
| 1868 | 21,541,573 | 1.21 | 26,141,900 | 10.08 | 263,589,235 | | | | | |
| 1869 | 18,591,281 | 1.42 | 26,420,000 | 10.18 | 268,933,048 | | | | | 6,723 |
| 1870 | 19,861,805 | 1.23 | 24,525,000 | 12.47 | 305,743,224 | | | | | 4,581 |
| 1871 | 19,009,052 | 1.17 | 22,239,400 | 14.30 | 317,939,799 | | | | | 5,266 |
| 1872 | 20,318,936 | 1.17 | 23,812,800 | 12.94 | 308,024,517 | | | | | 4,557 |
| 1873 | 21,894,084 | 1.15 | 25,085,100 | 12.53 | 314,241,037 | | | | | 4,889 |
| 1874 | 21,769,772 | 1.15 | 25,133,900 | 11.94 | 300,222,454 | | | | | 7,183 |
| 1875 | 23,507,964 | 1.19 | 27,873,600 | 10.78 | 300,377,839 | | | | | 7,528 |
| 1876 | 25,282,797 | 1.22 | 30,867,100 | 8.97 | 276,991,422 | | | 9.00 | 10.00 | 7,287 |
| 1877 | 25,367,708 | 1.25 | 31,629,300 | 8.37 | 264,879,796 | 9.50 | 10.50 | 9.75 | 10.75 | 9,514 |
| 1878 | 26,931,300 | 1.47 | 39,608,296 | 7.20 | 285,015,625 | 8.00 | 8.50 | 9.00 | 11.50 | 8,127 |
| 1879 | 27,484,991 | 1.29 | 35,493,000 | 9.32 | 330,804,494 | 14.00 | 14.50 | 14.00 | 15.00 | 13,739 |
| 1880 | 25,863,955 | 1.23 | 31,925,233 | 11.65 | 371,811,084 | 15.00 | 15.50 | 17.00 | 19.00 | 12,662 |
| 1881 | 30,888,700 | 1.14 | 35,135,064 | 11.82 | 415,131,366 | 16.00 | 16.50 | 15.00 | 16.50 | 10,570 |
| 1882 | 32,339,585 | 1.18 | 38,138,049 | 9.70 | 369,958,158 | 11.50 | 12.25 | 12.00 | 13.00 | 13,309 |
| 1883 | 35,515,948 | 1.32 | 46,864,009 | 8.19 | 383,834,451 | 9.00 | 10.00 | 12.50 | 17.00 | 16,908 |
| 1884 | 38,571,593 | 1.26 | 48,470,460 | 8.17 | 396,139,309 | 10.00 | 11.50 | 15.50 | 17.50 | 11,142 |
| 1885 | 39,849,701 | 1.12 | 44,731,550 | 8.71 | 389,752,873 | 11.00 | 12.00 | 10.00 | 12.00 | 13,390 |
| 1886 | 36,501,688 | 1.15 | 41,796,499 | 8.46 | 353,437,699 | 9.50 | 10.50 | 11.00 | 12.50 | 13,873 |
| 1887 | 37,664,739 | 1.10 | 41,454,458 | 9.97 | 413,440,283 | 13.50 | 14.50 | 17.00 | 21.00 | 18,198 |
| 1888 | 38,591,903 | 1.21 | 46,643,094 | 8.76 | 408,499,565 | 11.00 | 11.50 | 10.50 | 11.00 | 21,928 |
| 1889 | 52,947,236 | 1.26 | 66,829,612 | 7.04 | 470,374,948 | 9.00 | 10.00 | 9.00 | 14.00 | 36,274 |
| 1890 | 50,712,513 | 1.19 | 60,197,589 | 7.87 | 473,569,972 | 9.00 | 10.50 | 12.50 | 15.50 | 28,066 |
| 1891 | 51,044,490 | 1.19 | 60,817,771 | 8.12 | 494,113,616 | 12.50 | 15.00 | 13.50 | 14.00 | 35,201 |
| 1892 | 50,853,061 | 1.18 | 59,823,735 | 8.20 | 490,427,798 | 11.00 | 11.50 | 12.00 | 13.50 | 33,084 |
| 1893 | 49,613,469 | 1.33 | 65,766,158 | 8.68 | 570,882,872 | 10.00 | 10.50 | 10.00 | 10.50 | 54,446 |
| 1894 | 48,321,272 | 1.14 | 54,874,408 | 8.54 | 468,578,321 | 10.00 | 11.00 | 10.00 | 10.25 | 47,117 |
| 1895 | 44,206,453 | 1.06 | 47,078,541 | 8.35 | 393,185,615 | 12.00 | 12.50 | 11.50 | 12.00 | 59,052 |
| 1896 | 43,259,756 | 1.37 | 59,282,158 | 6.55 | 388,145,614 | 8.00 | 8.50 | 8.50 | 9.00 | 61,658 |
| 1897 | 42,426,770 | 1.43 | 60,664,876 | 6.62 | 401,390,728 | 8.00 | 8.50 | 9.50 | 10.50 | 81,827 |
| 1898 | 42,780,827 | 1.55 | 66,376,920 | 6.00 | 398,060,647 | 8.00 | 8.25 | 9.50 | 10.50 | 64,916 |
| 1899 | 41,328,462 | 1.35 | 56,655,756 | 7.27 | 411,926,187 | 10.50 | 11.50 | 10.50 | 12.50 | 72,708 |
| 1900 | 39,132,890 | 1.28 | 50,110,906 | 8.89 | 445,538,870 | 11.50 | 14.00 | | | |

*Condition of hay crop in United States, monthly, 1885-1900.*

| Year. | Clover. June. | Clover. July. | Timothy. July. | Timothy. Aug. | Year. | Clover. June. | Clover. July. | Timothy. July. | Timothy. Aug. |
|---|---|---|---|---|---|---|---|---|---|
| 1885 | | | | | 1893 | 92.7 | 92.6 | 89.8 | 89.6 |
| 1886 | | | | 91.2 | 1894 | 87.8 | 80.2 | 77.3 | 75.6 |
| 1887 | | | | 80.6 | 1895 | 82.8 | 73.9 | 70.8 | 69.9 |
| 1888 | | | | | 1896 | 88.4 | 83.7 | 84.8 | 67.5 |
| 1889 | | | | 94.5 | 1897 | 96.0 | | | |
| 1890 | 95.1 | 94.0 | 93.9 | 93.6 | 1898 | | | | 99.3 |
| 1891 | 91.0 | 89.3 | 87.4 | 90.9 | 1899 | | | | 86.7 |
| 1892 | 94.9 | 95.5 | 96.8 | 93.2 | 1900 | | | | 79.9 |

*Acreage, production, and value of hay in the United States in 1900, by States.*

| States and Territories. | Acreage. | Average yield per acre. | Production. | Average farm price Dec. 1. | Average value per acre. | Farm value Dec. 1. |
|---|---|---|---|---|---|---|
| | *Acres.* | *Tons.* | *Tons.* | *Dollars.* | *Dollars.* | *Dollars.* |
| Maine | 937,774 | 0.90 | 843,997 | 12.95 | 11.66 | 10,929,761 |
| New Hampshire | 596,076 | .87 | 518,586 | 15.50 | 13.48 | 8,038,083 |
| Vermont | 860,100 | 1.24 | 1,066,524 | 11.05 | 13.70 | 11,785,090 |
| Massachusetts | 567,079 | .97 | 550,067 | 17.40 | 16.88 | 9,571,166 |
| Rhode Island | 72,278 | .92 | 66,496 | 18.70 | 17.20 | 1,243,475 |
| Connecticut | 480,237 | .89 | 427,411 | 16.73 | 14.89 | 7,150,586 |
| New York | 4,138,261 | .81 | 3,351,991 | 14.05 | 11.38 | 47,095,474 |
| New Jersey | 396,113 | 1.26 | 499,102 | 16.05 | 20.22 | 8,010,587 |
| Pennsylvania | 2,429,601 | 1.10 | 2,672,561 | 13.90 | 15.29 | 37,148,598 |
| Delaware | 45,348 | .98 | 44,441 | 13.95 | 13.67 | 619,952 |
| Maryland | 277,332 | 1.09 | 302,292 | 14.05 | 15.31 | 4,247,203 |
| Virginia | 507,873 | 1.16 | 589,133 | 13.30 | 15.43 | 7,835,469 |
| North Carolina | 125,305 | 1.41 | 176,680 | 11.20 | 15.79 | 1,978,816 |
| South Carolina | 145,798 | 1.32 | 192,453 | 11.50 | 15.18 | 2,213,210 |
| Georgia | 112,566 | 1.69 | 190,237 | 12.75 | 21.55 | 2,425,522 |
| Florida | 5,348 | 1.20 | 6,418 | 13.70 | 16.44 | 87,927 |
| Alabama | 50,844 | 1.85 | 94,061 | 10.55 | 19.52 | 992,344 |
| Mississippi | 57,098 | 1.75 | 99,922 | 9.95 | 17.41 | 994,224 |
| Louisiana | 25,151 | 2.00 | 50,302 | 9.40 | 18.80 | 472,839 |
| Texas | 304,933 | 1.80 | 548,879 | 6.80 | 12.24 | 3,732,377 |
| Arkansas | 140,233 | 1.63 | 228,580 | 8.85 | 14.43 | 2,022,933 |
| Tennessee | 223,880 | 1.40 | 313,432 | 11.80 | 16.52 | 3,698,498 |
| West Virginia | 464,068 | 1.18 | 547,600 | 13.40 | 15.81 | 7,337,840 |
| Kentucky | 278,617 | 1.40 | 390,064 | 11.35 | 15.89 | 4,427,226 |
| Ohio | 1,559,242 | 1.06 | 1,652,797 | 11.05 | 11.71 | 18,263,407 |
| Michigan | 1,339,238 | 1.29 | 1,727,617 | 9.45 | 12.19 | 16,325,981 |
| Indiana | 1,374,754 | 1.21 | 1,663,452 | 9.75 | 11.80 | 16,218,657 |
| Illinois | 1,668,834 | 1.27 | 2,119,419 | 8.40 | 10.67 | 17,803,120 |
| Wisconsin | 1,059,438 | 1.15 | 1,218,354 | 9.65 | 11.10 | 11,757,116 |
| Minnesota | 1,227,021 | 1.16 | 1,423,344 | 6.95 | 8.06 | 9,892,241 |
| Iowa | 3,525,683 | 1.42 | 5,006,470 | 6.80 | 9.66 | 34,043,996 |
| Missouri | 2,145,748 | 1.29 | 2,768,015 | 6.95 | 8.97 | 19,237,704 |
| Kansas | 3,054,137 | 1.32 | 4,031,461 | 4.55 | 6.01 | 18,343,148 |
| Nebraska | 1,912,673 | 1.38 | 2,639,489 | 5.15 | 7.11 | 13,593,368 |
| South Dakota | 1,749,319 | 1.18 | 2,064,196 | 3.95 | 4.66 | 8,153,574 |
| North Dakota | 268,834 | .92 | 247,327 | 5.65 | 5.20 | 1,397,398 |
| Montana | 369,161 | 1.60 | 590,658 | 8.70 | 13.92 | 5,138,725 |
| Wyoming | 293,718 | 1.68 | 493,446 | 7.30 | 12.26 | 3,602,156 |
| Colorado | 799,611 | 2.23 | 1,783,133 | 7.60 | 16.95 | 13,551,811 |
| New Mexico | 37,544 | 2.06 | 77,341 | 9.90 | 20.39 | 765,676 |
| Arizona | 24,862 | 2.31 | 57,431 | 11.30 | 26.10 | 648,970 |
| Utah | 192,398 | 2.65 | 509,855 | 7.95 | 21.07 | 4,053,347 |
| Nevada | 154,330 | 2.43 | 375,022 | 7.70 | 18.71 | 2,887,669 |
| Idaho | 235,394 | 2.80 | 659,103 | 6.50 | 18.20 | 4,284,170 |
| Washington | 391,894 | 2.16 | 846,491 | 9.50 | 20.52 | 8,041,664 |
| Oregon | 713,653 | 2.35 | 1,677,085 | 6.80 | 15.98 | 11,404,178 |
| California | 1,793,491 | 1.51 | 2,708,171 | 8.15 | 12.31 | 22,071,594 |
| United States | 39,132,890 | 1.28 | 50,110,906 | 8.89 | 11.39 | 445,538,870 |

*Average yield per acre of hay in the United States, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Maine | 0.95 | 0.90 | 0.92 | 0.95 | 1.02 | 1.00 | 1.10 | 1.20 | 0.90 | 0.90 |
| New Hampshire | .92 | .90 | 1.06 | .95 | .95 | .96 | 1.15 | 1.25 | .89 | .87 |
| Vermont | 1.60 | .95 | 1.11 | 1.20 | 1.07 | 1.25 | 1.30 | 1.45 | 1.14 | 1.24 |
| Massachusetts | 1.10 | 1.10 | 1.15 | 1.26 | 1.11 | 1.28 | 1.40 | 1.42 | 1.13 | .97 |
| Rhode Island | .85 | .90 | .83 | .75 | .91 | 1.10 | 1.15 | 1.18 | .89 | .92 |
| Connecticut | .90 | 1.00 | .99 | .87 | .85 | 1.07 | 1.20 | 1.31 | .94 | .89 |
| New York | 1.10 | 1.10 | 1.24 | 1.17 | .73 | .81 | 1.35 | 1.40 | 1.04 | .81 |
| New Jersey | 1.05 | 1.07 | .99 | 1.16 | 1.21 | 1.15 | 1.75 | 1.42 | .83 | 1.26 |
| Pennsylvania | 1.15 | 1.10 | 1.03 | 1.18 | 1.01 | 1.06 | 1.40 | 1.45 | 1.20 | 1.10 |
| Delaware | 1.10 | 1.00 | .75 | 1.30 | 1.23 | 1.10 | 1.35 | 1.38 | 1.04 | .98 |
| Maryland | 1.12 | .98 | 1.04 | 1.03 | 1.25 | .87 | 1.35 | 1.20 | 1.13 | 1.09 |
| Virginia | 1.13 | .95 | 1.11 | .72 | 1.13 | 1.08 | 1.08 | 1.32 | 1.10 | 1.16 |
| North Carolina | 1.10 | 1.20 | 1.70 | 1.45 | 1.63 | 1.26 | 1.25 | 1.70 | 1.50 | 1.41 |
| South Carolina | 1.15 | 1.20 | 1.57 | 1.53 | 1.00 | 1.33 | 1.00 | 1.60 | 1.22 | 1.32 |
| Georgia | 1.17 | 1.35 | 1.32 | 1.16 | 1.60 | 1.38 | 1.35 | 1.75 | 1.45 | 1.69 |
| Florida | ...... | ...... | 2.00 | 1.23 | 1.53 | 1.40 | 1.00 | 1.60 | 1.46 | 1.20 |
| Alabama | 1.30 | 1.30 | 1.52 | 2.68 | 1.56 | 1.40 | 1.45 | 1.90 | 1.66 | 1.85 |
| Mississippi | 1.30 | 1.35 | 1.65 | 1.84 | 1.95 | 1.35 | 1.48 | 1.90 | 1.44 | 1.75 |
| Louisiana | 1.30 | 1.40 | 1.62 | 1.96 | 2.02 | 1.90 | 1.90 | 2.10 | 1.95 | 2.00 |
| Texas | 1.31 | 1.05 | 1.04 | 1.33 | 1.48 | 1.00 | 1.40 | 1.50 | 1.43 | 1.80 |
| Arkansas | 1.30 | 1.15 | 1.17 | 1.32 | 1.20 | 1.18 | 1.30 | 1.54 | 1.48 | 1.63 |
| Tennessee | 1.20 | 1.10 | 1.39 | 1.18 | 1.39 | 1.40 | 1.45 | 1.50 | 1.31 | 1.40 |
| West Virginia | 1.18 | 1.00 | 1.10 | 1.02 | .71 | 1.22 | 1.35 | 1.54 | 1.29 | 1.18 |
| Kentucky | 1.18 | 1.15 | 1.33 | 1.26 | 1.35 | 1.20 | 1.17 | 1.45 | 1.29 | 1.40 |

*Average yield per acre of hay in the United States, 1891–1900, by States,*.—Continued.

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| Ohio | 1.20 | 1.15 | 1.33 | 1.27 | .58 | 1.26 | 1.44 | 1.39 | 1.30 | 1.06 |
| Michigan | 1.15 | 1.20 | 1.46 | 1.20 | .58 | 1.16 | 1.49 | 1.36 | 1.22 | 1.29 |
| Indiana | 1.20 | 1.20 | 1.36 | 1.27 | .61 | 1.30 | 1.43 | 1.45 | 1.34 | 1.21 |
| Illinois | 1.25 | 1.25 | 1.21 | 1.14 | .66 | 1.38 | 1.29 | 1.56 | 1.29 | 1.27 |
| Wisconsin | 1.12 | 1.20 | 1.52 | 1.31 | .88 | 1.25 | 1.35 | 1.50 | 1.47 | 1.15 |
| Minnesota | 1.15 | 1.25 | 1.62 | 1.02 | 1.30 | 1.69 | 1.57 | 1.80 | 1.70 | 1.16 |
| Iowa | 1.20 | 1.25 | 1.58 | .73 | 1.08 | 1.74 | 1.50 | 1.75 | 1.34 | 1.42 |
| Missouri | 1.15 | 1.15 | 1.24 | .85 | 1.17 | 1.43 | 1.15 | 1.60 | 1.37 | 1.29 |
| Kansas | 1.30 | 1.10 | 1.31 | .77 | 1.24 | 1.42 | 1.30 | 1.46 | 1.57 | 1.32 |
| Nebraska | 1.20 | 1.20 | 1.25 | .59 | .99 | 1.66 | 1.60 | 1.60 | 1.66 | 1.38 |
| South Dakota | 1.21 | 1.25 | 1.42 | .94 | .79 | 1.28 | 1.25 | 1.38 | 1.43 | 1.18 |
| North Dakota | 1.15 | 1.30 | 1.29 | 1.19 | 1.42 | 1.65 | 1.60 | 1.50 | 1.58 | .92 |
| Montana | 1.15 | 1.10 | 1.26 | 1.20 | .94 | 1.38 | 1.50 | 1.45 | 1.42 | 1.60 |
| Wyoming | .93 | 1.15 | 1.35 | 1.60 | 1.08 | 1.55 | 1.65 | 1.96 | 1.47 | 1.68 |
| Colorado | 1.88 | 2.00 | 1.19 | 2.27 | 2.42 | 2.20 | 2.25 | 2.20 | 2.10 | 2.23 |
| New Mexico | 1.10 | 1.20 | 2.08 | 1.88 | 2.61 | 3.00 | 3.50 | 3.75 | 1.70 | 2.06 |
| Arizona | ....... | 1.30 | 1.75 | 1.82 | 1.85 | 3.20 | 3.00 | 3.50 | 2.63 | 2.31 |
| Utah | 1.40 | 1.40 | 1.72 | 2.52 | 2.56 | 2.70 | 2.95 | 3.25 | 2.50 | 2.65 |
| Nevada | 1.20 | 1.75 | 2.66 | 4.04 | 3.01 | 2.55 | 2.50 | 2.60 | 1.87 | 2.43 |
| Idaho | 1.20 | 1.50 | 2.45 | 2.53 | 2.57 | 2.60 | 2.30 | 3.75 | 2.50 | 2.80 |
| Washington | 1.45 | 1.40 | 1.58 | 2.05 | 1.85 | 1.95 | 2.25 | 1.75 | 2.02 | 2.16 |
| Oregon | 1.30 | 1.45 | 1.88 | 2.00 | 1.78 | 1.98 | 1.90 | 1.90 | 1.97 | 2.35 |
| California | 1.40 | 1.50 | 1.69 | 1.93 | 1.66 | 1.65 | 1.60 | 1.60 | 1.63 | 1.51 |
| General average | 1.18 | 1.18 | 1.33 | 1.14 | 1.06 | 1.37 | 1.43 | 1.55 | 1.35 | 1.28 |

*Average value per acre of hay in the United States, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| Maine | $8.84 | $11.52 | $11.16 | $9.12 | $9.87 | $10.25 | $10.73 | $9.12 | $9.09 | $11.66 |
| New Hampshire | 10.12 | 11.88 | 16.54 | 9.97 | 11.88 | 12.38 | 13.23 | 11.56 | 10.46 | 13.48 |
| Vermont | 14.40 | 9.50 | 11.80 | 11.93 | 13.11 | 12.85 | 12.03 | 9.21 | 10.55 | 13.70 |
| Massachusetts | 17.60 | 18.26 | 19.93 | 19.53 | 19.42 | 20.99 | 19.46 | 17.18 | 17.52 | 16.88 |
| Rhode Island | 13.81 | 15.66 | 16.27 | 12.25 | 15.70 | 18.26 | 16.67 | 14.93 | 15.35 | 17.20 |
| Connecticut | 14.17 | 16.50 | 17.32 | 13.54 | 13.68 | 15.74 | 15.60 | 14.61 | 13.63 | 14.89 |
| New York | 12.10 | 12.10 | 14.05 | 11.30 | 10.00 | 9.75 | 11.14 | 8.05 | 10.87 | 11.38 |
| New Jersey | 15.12 | 15.25 | 17.26 | 16.34 | 15.29 | 16.50 | 18.81 | 13.63 | 12.74 | 20.22 |
| Pennsylvania | 11.50 | 13.53 | 14.83 | 13.35 | 12.42 | 12.88 | 12.81 | 11.46 | 13.80 | 15.29 |
| Delaware | 13.20 | 12.33 | 12.75 | 19.50 | 14.96 | 14.30 | 13.50 | 11.66 | 12.12 | 13.67 |
| Maryland | 12.49 | 11.52 | 14.82 | 11.46 | 14.44 | 10.31 | 14.17 | 11.16 | 13.73 | 15.31 |
| Virginia | 12.43 | 10.92 | 14.53 | 8.56 | 12.92 | 11.03 | 11.07 | 11.22 | 11.27 | 15.43 |
| North Carolina | 12.10 | 12.66 | 18.89 | 15.85 | 16.53 | 13.55 | 12.19 | 15.81 | 15.15 | 15.79 |
| South Carolina | 14.01 | 13.56 | 15.18 | 16.45 | 7.62 | 15.06 | 11.50 | 15.20 | 12.56 | 15.18 |
| Georgia | 15.79 | 15.93 | 15.92 | 14.36 | 17.44 | 15.25 | 17.55 | 20.56 | 19.07 | 21.55 |
| Florida | 17.70 | 16.38 | 39.50 | 19.99 | 20.24 | 18.20 | 14.25 | 22.56 | 22.41 | 16.44 |
| Alabama | 16.09 | 14.04 | 17.08 | 25.49 | 15.93 | 13.72 | 13.86 | 17.57 | 18.92 | 19.52 |
| Mississippi | 14.59 | 13.38 | 15.86 | 17.79 | 18.91 | 12.77 | 14.06 | 15.96 | 13.32 | 17.41 |
| Louisiana | 15.05 | 13.72 | 14.58 | 28.85 | 19.47 | 16.63 | 16.62 | 19.74 | 18.92 | 18.80 |
| Texas | 11.46 | 8.99 | 9.98 | 10.13 | 9.52 | 7.20 | 10.15 | 8.77 | 10.15 | 12.24 |
| Arkansas | 13.74 | 10.05 | 10.96 | 11.66 | 11.12 | 8.90 | 11.25 | 10.39 | 12.80 | 14.43 |
| Tennessee | 13.56 | 11.44 | 14.96 | 13.30 | 15.05 | 13.54 | 15.59 | 14.25 | 14.74 | 16.52 |
| West Virginia | 10.82 | 10.50 | 14.02 | 10.87 | 9.04 | 11.94 | 11.95 | 12.94 | 12.19 | 15.81 |
| Kentucky | 11.98 | 10.92 | 13.51 | 13.19 | 14.77 | 11.35 | 11.70 | 13.19 | 13.42 | 15.89 |
| Ohio | 9.84 | 10.55 | 13.37 | 10.74 | 7.40 | 9.99 | 9.00 | 7.99 | 11.63 | 11.71 |
| Michigan | 12.65 | 10.08 | 13.37 | 10.85 | 7.59 | 9.84 | 11.55 | 9.72 | 10.37 | 12.19 |
| Indiana | 9.24 | 9.36 | 12.46 | 9.63 | 7.34 | 9.33 | 8.44 | 8.12 | 10.45 | 11.80 |
| Illinois | 9.65 | 9.41 | 10.72 | 9.50 | 6.77 | 8.82 | 7.93 | 9.20 | 10.00 | 10.67 |
| Wisconsin | 10.98 | 9.18 | 10.94 | 10.42 | 8.47 | 8.25 | 8.44 | 8.62 | 10.07 | 11.10 |
| Minnesota | 6.61 | 5.75 | 7.40 | 5.41 | 6.66 | 6.41 | 7.06 | 6.66 | 7.40 | 8.06 |
| Iowa | 6.60 | 6.56 | 9.73 | 5.39 | 6.97 | 6.94 | 6.37 | 7.09 | 7.10 | 9.66 |
| Missouri | 7.13 | 7.76 | 8.73 | 6.65 | 7.96 | 6.94 | 7.07 | 9.28 | 8.56 | 8.97 |
| Kansas | 4.71 | 4.84 | 6.14 | 4.04 | 4.04 | 3.83 | 4.42 | 4.74 | 5.49 | 6.01 |
| Nebraska | 3.80 | 5.12 | 6.09 | 4.20 | 3.52 | 4.05 | 4.80 | 5.28 | 6.14 | 7.11 |
| South Dakota | 5.08 | 4.25 | 5.21 | 4.02 | 2.60 | 3.99 | 3.69 | 4.14 | 4.43 | 4.66 |
| North Dakota | 4.60 | 5.33 | 4.80 | 4.61 | 4.94 | 5.59 | 5.20 | 4.87 | 5.21 | 5.20 |
| Montana | 9.77 | 9.85 | 9.94 | 8.60 | 10.72 | 9.47 | 11.63 | 9.86 | 10.93 | 13.92 |
| Wyoming | 8.37 | 7.36 | 10.80 | 16.10 | 7.02 | 11.07 | 9.90 | 11.40 | 9.70 | 12.26 |
| Colorado | 15.04 | 13.00 | 8.31 | 17.12 | 14.21 | 13.68 | 12.38 | 11.88 | 15.43 | 16.95 |
| New Mexico | 10.45 | 13.50 | 17.68 | 21.62 | 20.88 | 17.10 | 24.50 | 27.56 | 18.02 | 20.39 |
| Arizona | 9.90 | 13.65 | 14.44 | 21.84 | 16.65 | 28.00 | 15.00 | 42.00 | 27.22 | 26.10 |
| Utah | 7.70 | 8.83 | 8.89 | 14.01 | 13.49 | 13.50 | 14.01 | 14.62 | 17.75 | 21.07 |
| Nevada | 6.00 | 12.25 | 26.60 | 29.29 | 20.32 | 12.29 | 12.50 | 18.20 | 14.31 | 18.71 |
| Idaho | 8.00 | 11.10 | 13.48 | 10.98 | 16.06 | 12.25 | 12.08 | 18.37 | 15.75 | 18.20 |
| Washington | 15.22 | 12.60 | 14.49 | 15.13 | 12.49 | 13.83 | 20.25 | 13.30 | 17.98 | 20.52 |
| Oregon | 10.40 | 12.93 | 15.23 | 11.72 | 10.89 | 13.07 | 14.73 | 13.78 | 13.49 | 15.98 |
| California | 15.40 | 13.14 | 13.30 | 18.34 | 11.72 | 10.48 | 14.40 | 22.80 | 13.04 | 12.31 |
| General average | 9.68 | 9.64 | 11.51 | 9.70 | 8.89 | 8.97 | 9.46 | 9.30 | 9.97 | 11.39 |

*Average farm price of hay per ton in the United States December 1, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| Maine | $9.30 | $12.80 | $12.13 | $9.60 | $9.68 | $10.25 | $9.75 | $7.60 | $10.10 | $12.95 |
| New Hampshire | 11.00 | 13.20 | 15.60 | 10.50 | 12.50 | 12.90 | 11.50 | 9.25 | 11.75 | 15.50 |
| Vermont | 9.00 | 10.00 | 10.63 | 9.94 | 12.25 | 10.28 | 9.25 | 6.35 | 9.25 | 11.05 |
| Massachusetts | 16.00 | 16.60 | 17.33 | 15.50 | 17.50 | 16.40 | 13.90 | 12.10 | 15.50 | 17.40 |
| Rhode Island | 16.25 | 17.40 | 19.60 | 16.33 | 17.25 | 16.60 | 14.50 | 12.65 | 17.25 | 18.70 |
| Connecticut | 15.75 | 16.50 | 17.50 | 15.56 | 16.10 | 14.71 | 13.00 | 11.15 | 14.50 | 16.73 |
| New York | 11.00 | 11.00 | 11.33 | 9.66 | 13.70 | 12.04 | 8.25 | 5.75 | 10.45 | 14.05 |
| New Jersey | 14.40 | 14.25 | 17.43 | 14.09 | 12.64 | 14.35 | 10.75 | 9.60 | 15.35 | 16.05 |
| Pennsylvania | 10.00 | 12.30 | 14.40 | 11.31 | 12.30 | 12.15 | 9.15 | 7.90 | 11.50 | 13.90 |
| Delaware | 12.00 | 12.33 | 17.00 | 15.00 | 12.16 | 13.00 | 10.00 | 8.45 | 11.65 | 13.95 |
| Maryland | 11.15 | 11.75 | 14.25 | 11.13 | 11.55 | 11.85 | 10.50 | 9.30 | 12.15 | 14.05 |
| Virginia | 11.00 | 11.50 | 13.09 | 11.89 | 11.43 | 10.21 | 10.25 | 8.50 | 10.25 | 13.30 |
| North Carolina | 11.00 | 10 55 | 11.11 | 10.93 | 10.14 | 10.75 | 9.75 | 9.30 | 10.10 | 11.20 |
| South Carolina | 12.18 | 11.30 | 9.67 | 10.75 | 7.62 | 11.32 | 11.50 | 9.50 | 10.30 | 11.50 |
| Georgia | 13.50 | 11.80 | 12.06 | 12.38 | 10.90 | 11.05 | 13.00 | 11.75 | 13.15 | 12.75 |
| Florida | 15.00 | 14.00 | 19.75 | 16.25 | 13.23 | 13.00 | 14.25 | 14.10 | 15.35 | 13.70 |
| Alabama | 12.38 | 10.80 | 11.24 | 9.51 | 10.21 | 9.80 | 10.25 | 9.25 | 11.40 | 10.55 |
| Mississippi | 11.22 | 9.91 | 9.61 | 9.67 | 9.70 | 9.46 | 9.50 | 8.40 | 9.25 | 9.95 |
| Louisiana | 11.58 | 9.80 | 9.00 | 10.64 | 9.64 | 8.75 | 8.75 | 9.40 | 9.70 | 9.40 |
| Texas | 8.75 | 8.56 | 9.60 | 7.62 | 6.43 | 7.20 | 7.75 | 5.85 | 7.10 | 6.80 |
| Arkansas | 10.57 | 8.74 | 9.37 | 8.83 | 9.27 | 7.54 | 8.65 | 6.75 | 8.65 | 8.85 |
| Tennessee | 11.30 | 10.40 | 10.76 | 11.27 | 10.83 | 9.67 | 10.75 | 9.50 | 11.25 | 11.80 |
| West Virginia | 9.17 | 10.50 | 12.25 | 10.66 | 12.73 | 9.79 | 8.85 | 8.40 | 9.45 | 13.40 |
| Kentucky | 10.15 | 9.50 | 10.16 | 10.47 | 10.94 | 9.46 | 10.00 | 9.10 | 10.40 | 11.35 |
| Ohio | 8.20 | 9.17 | 10.05 | 8.46 | 12.76 | 7.93 | 6.25 | 5.75 | 8.95 | 11.05 |
| Michigan | 11.00 | 8.40 | 9.16 | 9.04 | 13.09 | 8.48 | 7.75 | 7.15 | 8.50 | 9.45 |
| Indiana | 7.70 | 7.80 | 9.16 | 7.58 | 12.03 | 7.18 | 5.90 | 5.60 | 7.80 | 9.75 |
| Illinois | 7.72 | 7.53 | 8.86 | 8.33 | 10.25 | 6.39 | 6.15 | 5.90 | 7.75 | 8.40 |
| Wisconsin | 9.80 | 7.65 | 7.20 | 7.96 | 9.63 | 6.60 | 6.25 | 5.75 | 6.85 | 9.65 |
| Minnesota | 5.75 | 4.60 | 4.57 | 5.30 | 5.12 | 3.79 | 4.50 | 3.70 | 4.35 | 6.95 |
| Iowa | 5.50 | 5.25 | 6.16 | 7.39 | 6.45 | 3.99 | 4.25 | 4.05 | 5.30 | 6.80 |
| Missouri | 6.20 | 6.75 | 7.04 | 7.82 | 6.80 | 4.85 | 6.15 | 5.80 | 6.25 | 6.95 |
| Kansas | 3.62 | 4.40 | 4.69 | 5.25 | 3.26 | 2.70 | 3.40 | 3.25 | 3.50 | 4.55 |
| Nebraska | 3.17 | 4.27 | 4.87 | 7.12 | 3.56 | 2.44 | 3.00 | 3.30 | 3.70 | 5.15 |
| South Dakota | 4.20 | 3.40 | 3.67 | 4.28 | 3.29 | 3.12 | 2.95 | 3.00 | 3.10 | 3.95 |
| North Dakota | 4.00 | 4.10 | 3.72 | 3.87 | 3.48 | 3.39 | 3.25 | 3.25 | 3.30 | 5.65 |
| Montana | 8.50 | 8.95 | 7.89 | 7.17 | 11.40 | 6.86 | 7.75 | 6.80 | 7.70 | 8.70 |
| Wyoming | 9.00 | 6.40 | 8.00 | 10.00 | 6.50 | 7.14 | 6.00 | 5.90 | 6.60 | 7.30 |
| Colorado | 8.00 | 6.50 | 6.98 | 7.54 | 5.87 | 6.22 | 5.50 | 5.40 | 7.35 | 7.60 |
| New Mexico | 9.50 | 11.25 | 8.50 | 11.50 | 8.00 | 5.70 | 7.00 | 7.35 | 10.60 | 9.90 |
| Arizona | ...... | 10.50 | 8.25 | 12.00 | 9.00 | 8.75 | 5.00 | 12.00 | 10.35 | 11.30 |
| Utah | 5.50 | 6.31 | 5.17 | 5.56 | 5.27 | 5.00 | 4.75 | 4.50 | 7.10 | 7.95 |
| Nevada | 5.00 | 7.00 | 10.00 | 7.25 | 6.75 | 4.82 | 5.00 | 7.00 | 7.65 | 7.70 |
| Idaho | 6.67 | 7.40 | 5.50 | 4.34 | 6.25 | 4.71 | 5.25 | 4.90 | 6.30 | 6.50 |
| Washington | 10.50 | 9.00 | 9.17 | 7.38 | 6.75 | 7.09 | 9.00 | 7.60 | 8.90 | 9.50 |
| Oregon | 8.00 | 8.92 | 8.10 | 5.86 | 6.12 | 6.60 | 7.75 | 7.25 | 6.85 | 6.80 |
| California | 11.00 | 8.76 | 7.87 | 9.50 | 7.06 | 6.35 | 9.00 | 14.25 | 8.00 | 8.15 |
| General average | 8.39 | 8.49 | 8.68 | 8.54 | 8.35 | 6.55 | 6.62 | 6.00 | 7.27 | 8.89 |

*Wholesale prices of hay (baled) in leading cities of the United States, 1896–1900.*

| Date. | New York. No. 1, per hundred weight. | | Chicago. No. 1 Timothy, per ton. | | Cincinnati. No. 1 Timothy, per ton. | | St. Louis. Choice Timothy, per ton. | |
|---|---|---|---|---|---|---|---|---|
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | | | | | | | | |
| January | $0.85 | $1.00 | $11.50 | $12.00 | $14.00 | $14.75 | $12.00 | $14.50 |
| February | .90 | .95 | 11.00 | 11.50 | 14.00 | 14.75 | 12.00 | 13.50 |
| March | .90 | .95 | 11.50 | 12.00 | 13.50 | 14.25 | 12.00 | 14.00 |
| April | .90 | 1.00 | 12.00 | 12.50 | 14.00 | 15.00 | 12.50 | 15.50 |
| May | .90 | 1.05 | 11.50 | 12.00 | 14.00 | 14.50 | 13.00 | 15.50 |
| June | .95 | 1.05 | 9.50 | 10.00 | 12.00 | 14.00 | 12.00 | 13.75 |
| July | .95 | 1.00 | 9.00 | 10.00 | 11.50 | 12.50 | 10.00 | 14.00 |
| August | .90 | 1.00 | 9.00 | 9.50 | 9.00 | 13.50 | 10.00 | 13.00 |
| September | .75 | .92½ | 8.00 | 8.50 | 9.00 | 10.50 | 9.00 | 11.00 |
| October | .75 | .90 | 8.00 | 8.50 | 9.50 | 10.50 | 9.50 | 12.00 |
| November | .82½ | .85 | 8.50 | 9.00 | 9.00 | 10.75 | 9.50 | 12.50 |
| December | .75 | .82½ | 8.00 | 8.50 | 9.00 | 10.75 | 10.50 | 12.50 |
| **1897.** | | | | | | | | |
| January | .75 | .85 | 8.00 | 8.50 | 10.00 | 10.50 | 9.50 | 11.00 |
| February | .77½ | .80 | 7.50 | 8.00 | 10.00 | 10.50 | 9.00 | 11.00 |
| March | .80 | .80 | 8.00 | 8.50 | 10.00 | 11.50 | 9.00 | 12.00 |
| April | .77½ | .85 | 8.00 | 8.50 | 10.50 | 11.50 | 11.00 | 14.00 |

*Wholesale prices of hay (baled) in leading cities of the United States, 1896–1900*—Continued.

| Date. | New York. | | Chicago. | | Cincinnati. | | St. Louis. | |
|---|---|---|---|---|---|---|---|---|
| | No. 1, per hundred weight. | | No. 1 Timothy, per ton. | | No. 1 Timothy, per ton. | | Choice Timothy, per ton. | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1897.** | | | | | | | | |
| May | $0.80 | $0.82½ | $8.50 | $9.00 | $11.00 | $11.50 | $11.50 | $13.75 |
| June | .75 | .80 | 8.50 | 9.00 | 9.50 | 11.00 | 9.25 | 12.75 |
| July | .77½ | .80 | 8.50 | 9.00 | 9.00 | 11.00 | 9.50 | 12.50 |
| August | .75 | .90 | 8.50 | 9.00 | 8.00 | 9.25 | 8.50 | 11.00 |
| September | .72½ | .80 | 8.50 | 9.00 | 8.00 | 8.75 | 8.50 | 10.00 |
| October | .75 | .80 | 8.00 | 8.50 | 8.00 | 8.25 | 9.00 | 10.50 |
| November | .75 | .80 | 8.00 | 8.50 | 8.00 | 9.00 | 9.00 | 10.50 |
| December | .75 | .80 | 8.00 | 8.50 | 8.50 | 9.00 | 9.75 | 11.00 |
| | | | | | | | No. 1 Timothy. | |
| **1898.** | | | | | | | | |
| January | .72½ | .80 | 8.00 | 8.50 | 8.50 | 9.00 | 8.25 | 9.50 |
| February | .72½ | .75 | 8.00 | 8.50 | 8.00 | 9.00 | 8.50 | 9.50 |
| March | .75 | .80 | 9.00 | 9.50 | 8.00 | 9.00 | 9.00 | 10.00 |
| April | .75 | .80 | 8.50 | 9.00 | 8.50 | 10.00 | 9.00 | 12.50 |
| May | .80 | .80 | 9.50 | 10.50 | 9.00 | 10.25 | 10.50 | 12.00 |
| June | .77½ | .80 | 9.00 | 9.50 | 8.25 | 9.00 | 10.50 | 11.50 |
| July | .77½ | .77½ | 8.00 | 8.50 | 8.25 | 9.00 | 9.00 | 10.00 |
| August | .70 | .77½ | 8.00 | 8.50 | 7.50 | 9.00 | 7.00 | 10.00 |
| September | .65 | .70 | 7.50 | 8.00 | 7.50 | 8.00 | 7.00 | 8.00 |
| October | .65 | .67½ | 7.50 | 8.00 | 7.75 | 8.25 | 7.00 | 8.50 |
| November | .65 | .65 | 8.00 | 8.50 | 8.00 | 8.00 | 7.50 | 8.50 |
| December | .65 | .67½ | 8.00 | 8.25 | 8.00 | 8.25 | 7.50 | 8.50 |
| **1899.** | | | | | | | | |
| January | .65 | .65 | 7.50 | 9.00 | 7.75 | 8.50 | 8.00 | 9.90 |
| February | .65 | .65 | 7.75 | 8.50 | 8.00 | 8.75 | 8.00 | 8.75 |
| March | .65 | .67½ | 8.50 | 10.00 | 9.00 | 11.00 | 8.00 | 10.00 |
| April | .67½ | .75 | 9.50 | 10.50 | 10.50 | 11.50 | 9.00 | 11.00 |
| May | .75 | .90 | 9.50 | 10.50 | 10.50 | 11.00 | 10.50 | 11.50 |
| June | .80 | .95 | 10.00 | 11.50 | 10.50 | 12.00 | 10.50 | 11.50 |
| July | .85 | .95 | 10.00 | 13.00 | 9.00 | 12.50 | 10.00 | 12.00 |
| August | .87½ | .95 | 9.00 | 13.00 | 9.00 | 10.50 | 8.00 | 12.00 |
| September | .80 | .90 | 9.50 | 11.50 | 9.00 | 11.25 | 8.00 | 10.50 |
| October | .80 | .92½ | 9.50 | 11.00 | 11.00 | 12.00 | 9.50 | 10.50 |
| November | .80 | .87½ | 10.50 | 11.50 | 11.50 | 13.00 | 10.00 | 10.75 |
| December | .87½ | .87½ | 10.50 | 11.50 | 12.00 | 13.00 | 10.00 | 11.50 |
| | | | | | | | Choice. | |
| **1900.** | | | | | | | | |
| January | .87½ | .87½ | 10.00 | 11.50 | 13.00 | 14.00 | 11.00 | 12.50 |
| February | .87½ | .87½ | 10.50 | 11.50 | 13.50 | 14.00 | 10.50 | 12.00 |
| March | .87½ | .90 | 10.50 | 11.50 | 13.75 | 14.25 | 11.00 | 12.50 |
| April | .90 | .90 | 10.50 | 14.00 | 14.50 | 15.00 | 11.50 | 13.00 |
| May | .90 | .95 | 10.50 | 12.50 | 14.25 | 15.00 | 11.00 | 13.50 |
| June | .90 | .92½ | 10.00 | 11.50 | 14.00 | 14.75 | 10.50 | 13.50 |
| July | .90 | .95 | 10.50 | 12.50 | 13.75 | 15.00 | 11.00 | 14.50 |
| August | .90 | .97½ | 11.00 | 12.50 | 11.50 | 15.00 | 9.75 | 13.00 |
| September | .90 | .95 | 11.00 | 12.00 | 12.50 | 13.75 | 10.00 | 12.00 |
| October | .95 | .95 | 11.00 | 12.00 | 13.50 | 14.50 | 11.00 | 12.50 |
| November | .92½ | .95 | 11.50 | 13.50 | 13.50 | 14.00 | 10.75 | 13.50 |
| December | .90 | .95 | 11.50 | 14.00 | 13.75 | 14.25 | 11.50 | 14.00 |

## COTTON.

The commercial cotton-crop year, which ended August 31, 1900, was, in some respects, one of the most remarkable in the history of this industry. There never was a time when so many American spindles were in operation, and rarely, if ever, a time when they were so severely taxed to meet the demand for cotton goods. Such was the activity that many mills, both North and South, were obliged to run day and night, and but for the complications in China the latter part of the season, the whole of the year would have been one of remarkable prosperity to manufacturers of this staple.

In consequence of the great demand for American cotton goods the United States consumed more raw cotton than any other country, leading Great Britain, which for a century and more has held supremacy in this industry, by over half a million bales.

But perhaps the most extraordinary feature of the year was the wide range of prices from the beginning to the close of the season. Spot cotton opened in New Orleans on September 1, 1899, at 5 15/16, and in New York at 6¼ cents a pound for middling upland, and on the last day of the season, August 31, sold in New Orleans at

$9\frac{1}{2}$ and in New York at $9\frac{5}{8}$ cents per pound, a difference of $3\frac{9}{16}$ cents in the former and of $3\frac{3}{8}$ in the latter market. The difference, however, to the planter was not so great as this, as the average price of spot cotton in September in New Orleans was about 6 cents, and in January (when the season is practically over with the planter) $7\frac{1}{2}$ cents, a difference of $1\frac{1}{2}$ cents, or about $7.50 for a bale of 500 pounds.

Another noteworthy feature of this crop is its total value as compared with that of 1898-99, the largest crop ever made; for, although over 2,000,000 bales less, its value is over $29,000,000 greater.

In estimating the crop of the States and Territories the Department has followed its usual method, the statistical data used being furnished by the officials of the rail and water lines that have transported cotton from the States of production, by the officials of the mills located in those States, and by special agents of the Department at the Southern ports and important receiving points in the interior. The reports from these sources are condensed in the accompanying table, so as to show the number of bales of cotton moved from each State and Territory to the ports, to Northern and Western mills, to Canada, and all other foreign destinations; the number taken from the current crop by the mills; the number forwarded from one cotton State to the markets and mills of another, and the number taken by the mills from the ports.

The column "Taken from other States" includes all cotton forwarded by rail, water, and wagon from interior points and plantations of one State to interior markets of another; also all cotton shipped from interior points of one State to the mills of another—all of which is first credited to the State in which it originates. The amount of cotton taken from other States is 72,050 bales greater than in 1898-99, due almost wholly to the increased demand of Southern mills. In further explanation of the large amount of cotton "taken from other States," it may be stated that at points like Augusta and Columbus, Ga., there are large deliveries of cotton by rail, water, and wagon from adjacent plantations in South Carolina and Alabama. There are also considerable deliveries from Alabama plantations at Columbus and Meridian, Miss., and from Indian Territory plantations at Denison, Gainesville, and Sherman, Tex. At Shreveport, La., the receipts from Texas, Arkansas, and Indian Territory are very large. Moreover, the mills of nearly all the cotton States obtain supplies from other States at some time or other during the year. Hence, such movements from one State into another are deducted, otherwise there would be a duplication.

"Taken from ports" includes only the cotton purchased at the ports by mills situated in the cotton States, and which has already been counted in the movement to the ports. The amount thus obtained by the mills is 10,505 bales greater than in 1898-99, and is likewise due to the scarcity of cotton and the unusual activity of the Southern mills.

The cotton produced in Kansas was partly used by local mills and partly marketed at St. Louis, and that in Kentucky was forwarded by river to St. Louis. The 26 bales made in Utah were used in one of the local mills.

All round bales of light weight, that is, bales weighing about 260 pounds, are counted as half bales.

*Condition of cotton crop in the United States, monthly, 1885-1900.*

| Year. | June. | July. | August. | September. | October. | Year. | June. | July. | August. | September. | October. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1885 | 92.0 | 96.0 | 96.5 | 87.0 | 78.0 | 1893 | 85.6 | 82.7 | 80.4 | 73.4 | 70.7 |
| 1886 | 88.7 | 86.1 | 81.3 | 82.1 | 79.3 | 1894 | 88.3 | 89.6 | 91.8 | 85.9 | 82.7 |
| 1887 | 96.9 | 96.9 | 93.3 | 82.8 | 76.5 | 1895 | 81.0 | 82.3 | 77.9 | 70.8 | 65.1 |
| 1888 | 88.2 | 86.7 | 87.3 | 83.8 | 78.9 | 1896 | 97.2 | 92.5 | 80.1 | 64.2 | 60.7 |
| 1889 | 86.4 | 87.6 | 89.3 | 86.6 | 81.5 | 1897 | 83.5 | 86.0 | 86.9 | 78.3 | 70.0 |
| 1890 | 88.8 | 91.4 | 89.5 | 85.5 | 80.0 | 1898 | 89.0 | 91.2 | 91.2 | 79.8 | 75.4 |
| 1891 | 85.7 | 88.6 | 88.9 | 82.7 | 75.7 | 1899 | 85.7 | 87.8 | 84.0 | 68.5 | 62.4 |
| 1892 | 85.9 | 86.9 | 82.3 | 76.8 | 73.3 | 1900 | 82.5 | 75.8 | 76.0 | 68.2 | 67.0 |

*Cotton crop of 1899–1900.*

[In commercial bales.]

| States and Territories. | Movement and mill purchases. | | | Taken from other States and ports. | | | Total crop. |
|---|---|---|---|---|---|---|---|
| | Forwarded by rail, etc. | Bought by mills. | Total. | Taken from other States. | Taken from ports. | Total. | |
| Alabama | 893,827 | 154,841 | 1,048,668 | 41,453 | 1,902 | 43,355 | 1,005,313 |
| Arkansas | 691,061 | 2,394 | 693,455 | 24,070 | .......... | 24,070 | 669,385 |
| Florida | 41,880 | .......... | 41,880 | 25 | .......... | 25 | 41,855 |
| Georgia | 1,151,932 | 318,302 | 1,470,234 | 122,387 | 2,148 | 124,535 | 1,345,699 |
| Indian Territory | 119,939 | .......... | 119,939 | .......... | .......... | .......... | 119,939 |
| Kentucky | 24 | 26,088 | 26,032 | 26,008 | .......... | 26,008 | 24 |
| Louisiana | 798,221 | 15,695 | 813,916 | 98,855 | 15,585 | 114,440 | 699,476 |
| Mississippi | 1,243,588 | 21,440 | 1,265,028 | 61,206 | 83 | 61,289 | 1,203,739 |
| Missouri | 17,275 | 3,720 | 20,995 | 3,720 | .......... | 3,720 | 17,275 |
| North Carolina | 218,456 | 442,508 | 660,964 | 148,487 | 8,652 | 157,139 | 503,825 |
| Oklahoma | 66,555 | .......... | 66,555 | .......... | .......... | .......... | 66,555 |
| South Carolina | 465,328 | 489,559 | 954,887 | 119,100 | 5,073 | 124,173 | 830,714 |
| Tennessee | 188,579 | 34,882 | 223,461 | 27,429 | 3,769 | 31,198 | 192,263 |
| Texas | 2,460,232 | 16,868 | 2,477,100 | 32,446 | 6,099 | 38,545 | 2,438,555 |
| Kansas and Utah | 88 | 186 | 274 | 60 | .......... | 60 | 214 |
| Virginia | 8,007 | 44,595 | 52,602 | 44,595 | .......... | 44,595 | 8,007 |
| United States | 8,364,992 | 1,570,998 | 9,935,990 | 749,841 | 43,311 | 793,152 | 9,142,838 |

*Value of the crop of 1899–1900.*

| States and Territories. | Upland crop. | | | | Sea-island crop. | | | | Total value. |
|---|---|---|---|---|---|---|---|---|---|
| | Production. | Weight per bale. | Price per pound. | Value. | Production. | Weight per bale. | Price per pound. | Value. | |
| | *Bales.* | *Lbs.* | *Cents.* | *Dollars.* | *Bales.* | *Lbs.* | *Cents.* | *Dollars.* | *Dollars.* |
| Alabama | 1,005,313 | 503 | 7.09 | 35,852,176 | ....... | ....... | ....... | .......... | 35,852,176 |
| Arkansas | 669,385 | 500 | 7.26 | 24,298,676 | ....... | ....... | ....... | .......... | 24,298,676 |
| Florida | 12,248 | 490 | 7.11 | 426,708 | 29,607 | 397 | 15.0 | 1,763,097 | 2,189,805 |
| Georgia | 1,284,811 | 490 | 7.11 | 44,761,530 | 60,888 | 397 | 13.5 | 3,263,292 | 48,024,822 |
| Indian Territory | 119,939 | 520 | 7.27 | 4,534,174 | ....... | ....... | ....... | .......... | 4,534,174 |
| Kansas | 188 | 500 | 7.26 | 6,824 | ....... | ....... | ....... | .......... | 6,824 |
| Kentucky | 24 | 500 | 7.26 | 871 | ....... | ....... | ....... | .......... | 871 |
| Louisiana | 699,476 | 509 | 7.21 | 25,670,000 | ....... | ....... | ....... | .......... | 25,670,000 |
| Mississippi | 1,203,739 | 509 | 7.21 | 44,175,897 | ....... | ....... | ....... | .......... | 44,175,897 |
| Missouri | 17,275 | 500 | 7.26 | 627,082 | ....... | ....... | ....... | .......... | 627,082 |
| North Carolina | 503,825 | 490 | 7.35 | 18,145,257 | ....... | ....... | ....... | .......... | 18,145,257 |
| Oklahoma | 66,555 | 520 | 7.26 | 2,512,584 | ....... | ....... | ....... | .......... | 2,512,584 |
| South Carolina | 822,871 | 492 | 7.12 | 28,825,500 | 7,843 | 352 | 20.0 | 552,147 | 29,377,647 |
| Tennessee | 192,263 | 500 | 7.23 | 6,950,307 | ....... | ....... | ....... | .......... | 6,950,307 |
| Texas | 2,438,555 | 520 | 7.27 | 92,187,133 | ....... | ....... | ....... | .......... | 92,187,133 |
| Utah | 26 | 500 | 7.26 | 944 | ....... | ....... | ....... | .......... | 944 |
| Virginia | 8,007 | 499 | 7.35 | 293,669 | ....... | ....... | ....... | .......... | 293,669 |
| United States | 9,044,500 | 505 | 7.20 | 329,269,332 | 98,338 | 393 | 14.4 | 5,578,536 | 334,847,868 |

*Cost of picking the cotton crops of 1898–99 and 1899–1900.*

| States and Territories. | 1899–1900. | | | 1898–1899. | | |
|---|---|---|---|---|---|---|
| | Pounds of lint. | Cost per 100 pounds. | Total cost. | Pounds of lint. | Cost per 100 pounds. | Total cost. |
| | *Thousands of pounds.* | *Cents.* | *Dollars.* | *Thousands of pounds.* | *Cents.* | *Dollars.* |
| Alabama | 1,441,619 | 36 | 5,189,828 | 1,721,725 | 35 | 6,026,038 |
| Arkansas | 953,874 | 43 | 4,101,658 | 1,343,344 | 44 | 5,910,714 |
| Florida | 17,086 | 46 | 78,596 | 19,463 | 58 | 112,885 |
| Georgia | 1,792,311 | 38 | 6,810,782 | 1,894,529 | 35 | 6,630,852 |
| Indian Territory | 178,109 | 51 | 908,356 | 317,369 | 49 | 1,555,108 |
| Louisiana | 1,015,639 | 40 | 4,062,556 | 1,059,386 | 42 | 4,449,421 |
| Mississippi | 1,747,829 | 39 | 6,816,533 | 1,840,761 | 42 | 7,731,196 |
| Missouri | 24,617 | 50 | 123,085 | 48,388 | 51 | 246,779 |
| North Carolina | 702,836 | 36 | 2,530,210 | 893,431 | 37 | 3,305,695 |
| Oklahoma | 98,834 | 58 | 573,237 | 166,483 | 62 | 1,032,195 |
| South Carolina | 1,152,842 | 38 | 4,380,800 | 1,424,124 | 37 | 5,269,259 |
| Tennessee | 273,975 | 46 | 1,260,285 | 471,640 | 44 | 2,075,216 |
| Texas | 3,621,254 | 44 | 15,933,518 | 5,135,467 | 47 | 24,136,695 |
| Virginia | 11,386 | 37 | 42,128 | 19,684 | 33 | 64,957 |
| United States | 13,032,211 | 40.5 | 52,811,572 | 16,355,794 | 41.9 | 68,547,010 |

*Progress of cotton spinning in the cotton States.*

| States. | No. of spindles. | | No. of mills in operation. | | | | New mills, 1900. | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1890. | 1900. | 1890. | 1897–1898. | 1898–1899. | 1899–1900. | Completed, etc. | Projected. | Total. |
| Alabama | 79,234 | 437,200 | 13 | 37 | 38 | 44 | 5 | 5 | 10 |
| Arkansas | [1] 66,980 | 17,160 | 1 | 2 | 3 | 4 | 1 | ........ | 1 |
| Louisiana | | 62,222 | 2 | 3 | 3 | 5 | 3 | ........ | 3 |
| Missouri | | 15,744 | 1 | 3 | 3 | 4 | ........ | ........ | ........ |
| Texas | | 60,876 | 1 | 4 | 5 | 6 | 3 | 3 | 6 |
| Georgia | 445,452 | 969,364 | 53 | 77 | 79 | 86 | 28 | 13 | 41 |
| Kansas | .......... | 2,000 | ...... | ........ | ........ | 1 | ........ | ........ | ........ |
| Kentucky | 42,942 | 68,730 | 5 | 11 | 11 | 10 | ........ | ........ | ........ |
| Mississippi | 57,004 | 88,584 | 9 | 7 | 7 | 10 | 7 | 2 | 9 |
| North Carolina | 337,786 | 1,264,509 | 91 | 161 | 169 | 190 | 28 | 6 | 34 |
| South Carolina | 332,784 | 1,693,649 | 34 | 76 | 80 | 93 | 25 | 2 | 27 |
| Tennessee | 97,524 | 155,997 | 20 | 29 | 29 | 32 | 5 | 3 | 8 |
| Virginia | 94,294 | 165,452 | 9 | 15 | 17 | 15 | ........ | ........ | ........ |
| Total | 1,554,000 | 5,001,487 | 239 | 425 | 441 | 500 | 105 | 34 | 139 |

[1] Details for each State not given in census report for 1890.

*Cotton acreage from 1894 to 1899, inclusive.*

| States and Territories. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. |
|---|---|---|---|---|---|---|
| Alabama | 2,664,861 | 2,371,726 | 2,656,333 | 2,709,460 | 3,003,176 | 2,883,049 |
| Arkansas | 1,483,319 | 1,186,655 | 1,542,652 | 1,619,785 | 1,876,467 | 1,726,350 |
| Florida | 201,621 | 191,540 | 264,325 | 251,109 | 152,452 | 149,403 |
| Georgia | 3,610,968 | 3,069,323 | 3,468,335 | 3,537,702 | 3,535,205 | 3,287,741 |
| Indian Territory | 233,898 | 212,847 | 141,124 | 317,992 | 314,906 | 299,161 |
| Kansas | 168 | 40 | 150 | 285 | 8 | 414 |
| Kentucky | (a) | (a) | 1,200 | 105 | 137 | 70 |
| Louisiana | 1,313,296 | 1,142,568 | 1,245,399 | 1,245,399 | 1,281,691 | 1,179,156 |
| Mississippi | 2,826,272 | 2,487,119 | 2,835,316 | 2,778,610 | 2,900,298 | 2,784,286 |
| Missouri | 63,696 | 47,772 | 77,868 | 83,319 | 82,318 | 41,340 |
| North Carolina | 1,296,522 | 1,050,183 | 1,228,714 | 1,302,437 | 1,311,708 | 1,219,888 |
| Oklahoma | 28,992 | 26,093 | 78,550 | 216,664 | 215,893 | 208,553 |
| South Carolina | 2,160,391 | 1.814,728 | 2,014,348 | 2,074,778 | 2,353,213 | 2,212,020 |
| Tennessee | 888,197 | 712,763 | 912,337 | 967,077 | 896,722 | 734,415 |
| Texas | 6,854,621 | 5,826,428 | 6,758,656 | 7,164,175 | 6,991,904 | 6,642,309 |
| Utah | .......... | 400 | 155 | 75 | 35 | 40 |
| Virginia | 61,128 | 44,623 | 47,747 | 50,612 | 51,162 | 35,302 |
| United States | 23,687,950 | 20,184,808 | 23,273,209 | 24,319,584 | 24,967,295 | 23,403,497 |

*Cotton crops from 1894–95 to 1899–1900, inclusive.*

[In commercial bales.]

| States and Territories. | 1894–95. | 1895–96. | 1896–97. | 1897–98. | 1898–99. | 1899–1900. |
|---|---|---|---|---|---|---|
| Alabama | 900,439 | 663,916 | 833,789 | 1,112,681 | 1,176,042 | 1,005,313 |
| Arkansas | 748,206 | 520,860 | 605,643 | 942,267 | 919,469 | 669,385 |
| Florida | 50,729 | 38,722 | 48,730 | 53,657 | 35,064 | 41,855 |
| Georgia | 1,247,952 | 1,067,377 | 1,299,340 | 1,350,781 | 1,378,731 | 1,345,699 |
| Indian Territory | 120,982 | 68,668 | 87,705 | 207,386 | 207,838 | 119,939 |
| Kansas | 67 | 15 | 61 | 139 | 3 | 188 |
| Kentucky | ([1]) | ([1]) | 414 | 35 | 50 | 24 |
| Louisiana | 760,757 | 513,843 | 567,251 | 788,325 | 717,747 | 699,476 |
| Mississippi | 1,231,227 | 1,013,358 | 1,201,000 | 1,524,771 | 1,247,128 | 1,203,739 |
| Missouri | 25,476 | 11,816 | 24,119 | 26,848 | 33,120 | 17,275 |
| North Carolina | 479,441 | 397,752 | 521,795 | 646,726 | 629,620 | 503,825 |
| Oklahoma | 14,584 | 14,103 | 35,251 | 110,175 | 109,026 | 66,555 |
| South Carolina | 862,604 | 764,700 | 936,463 | 1,030,085 | 1,035,414 | 830,714 |
| Tennessee | 304,981 | 172,560 | 236,781 | 268,635 | 322,820 | 192,263 |
| Texas | 3,140,392 | 1,905,337 | 2,122,701 | 2,822,408 | 3,363,109 | 2,438,555 |
| Utah | .......... | 103 | 123 | 60 | 34 | 26 |
| Virginia | 13,414 | 7,964 | 11,539 | 12,878 | 13,990 | 8,007 |
| United States | 9,901,251 | 7,161,094 | 8,532,705 | 10,897,857 | 11,189,205 | 9,142,838 |

[1] No data.

*Exports of cotton from United States to foreign countries.*

[In bales of 500 pounds.]

| Countries. | Year ended June 30, 1898. | | Year ended June 30, 1899. | | Year ended June 30, 1900. | |
|---|---|---|---|---|---|---|
| | Bales. | Value. | Bales. | Value. | Bales. | Value. |
| Austria-Hungary | 35,614 | $987,724 | 57,127 | $1,576,175 | 44,919 | $1,758,164 |
| Belgium | 161,942 | 4,809,609 | 129,525 | 3,599,471 | 148,319 | 5,680,303 |
| Denmark | 24,741 | 732,810 | 39,249 | 1,078,300 | 31,990 | 1,251,325 |
| France | 842,038 | 24,599,724 | 803,406 | 21,946,691 | 736,092 | 27,729,378 |
| Germany | 1,858,524 | 54,886,245 | 1,728,975 | 47,346,679 | 1,619,173 | 63,476,825 |
| Greece | | | | | 400 | 18,200 |
| Italy | 387,581 | 11,468,025 | 417,353 | 11,652,768 | 443,951 | 17,441,121 |
| Netherlands | 43,509 | 1,292,788 | 51,621 | 1,401,040 | 74,635 | 2,818,248 |
| Portugal | 18,835 | 588,923 | 21,627 | 612,132 | 18,472 | 723,774 |
| Russia | 103,825 | 3,133,758 | 95,011 | 2,796,793 | 54,950 | 2,258,026 |
| Spain | 263,648 | 8,180,970 | 248,635 | 7,194,000 | 246,612 | 9,618,930 |
| Sweden and Norway | 25,613 | 744,287 | 23,624 | 703,503 | 14,773 | 597,244 |
| United Kingdom | 3,532,101 | 105,853,614 | 3,609,444 | 99,709,352 | 2,302,128 | 90,202,651 |
| Dominion of Canada | 122,495 | 3,961,586 | 98,230 | 2,994,674 | 109,982 | 4,207,463 |
| Mexico | 42,433 | 1,321,473 | 36,130 | 1,043,473 | 18,522 | 814,231 |
| West Indies (French) | 17 | 653 | 5 | 187 | 2 | 84 |
| Chinese Empire | 11,302 | 370,670 | 4,060 | 131,734 | 11,215 | 460,385 |
| East Indies (British) | 297 | 9,130 | 9 | 308 | 1,601 | 55,265 |
| Hongkong | 1,800 | 72,000 | 56 | 1,710 | | |
| Japan | 224,214 | 7,428,226 | 182,734 | 5,775,784 | 323,203 | 12,712,619 |
| All other countries | | | | | 227 | 8,501 |
| Total | 7,700,529 | 230,442,215 | 7,546,821 | 209,564,774 | 6,201,166 | 241,832,737 |

*Imports of raw cotton into the United States, 1896 to 1900.*

| Countries. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|
| France | | | | | 30 |
| Germany | 26,737 | 23,460 | 26,039 | | 13,401 |
| Russia (on Black Sea) | 1,950 | | | | |
| United Kingdom | 9,530,252 | 13,236,095 | 12,594,972 | 10,562,308 | 10,478,611 |
| Newfoundland and Labrador | | | | | 40,120 |
| Quebec, Ontario, Manitoba, etc | | 31,219 | 50,842 | 34,849 | |
| British Columbia | | | 5 | 50,492 | |
| Nicaragua | | | | | 3,494 |
| Mexico | 3,145 | 2,500 | 13,167 | 178,352 | |
| West Indies (British) | 3,442 | 1,700 | | 1,241 | 500 |
| Haiti | | 12,992 | | | 60 |
| Brazil | | | | | 583 |
| Chile | 4,561 | 24,175 | 4,240 | | 69,471 |
| Colombia | | | | | 29,549 |
| Ecuador | 21,625 | 4,321 | | 25,731 | 25,000 |
| Peru | 1,661,333 | 880,154 | 1,296,236 | 1,501,498 | 2,787,265 |
| China | 55,075 | 64,383 | 66,321 | | 3,150 |
| East Indies (British) | 9,360 | 40,080 | 29,612 | 189,804 | 217,323 |
| East Indies (Dutch) | | 18,040 | 32,133 | | |
| Hongkong | 10 | 3,571 | | | |
| Japan | | 2,213 | | | |
| Turkey in Asia | 35,441 | | | | |
| Australasia (British) | 52,206 | | 259,818 | 97,125 | 141,185 |
| Oceania (French) | 370,614 | 230,774 | 48,267 | 10,696 | 34,193 |
| Africa (British) | | | 73,550 | | |
| Egypt | 43,574,769 | 37,323,249 | 38,165,061 | 37,506,062 | 53,554,586 |
| Total in pounds | 55,350,520 | 51,898,926 | 52,660,363 | 50,158,158 | 67,398,521 |
| Total in bales of 500 pounds | 110,701 | 103,798 | 105,321 | 100,316 | 134,797 |

*The world's consumption of cotton, 1890–91 to 1899–1900.*

[In bales of 500 pounds.]

| Year ended Sept. 30— | Great Britain. | Continent of Europe. | United States. | India. | All other countries. | Total. |
|---|---|---|---|---|---|---|
| 1891 | 3,384,000 | 3,631,000 | 2,367,000 | 924,000 | 150,000 | 10,456,000 |
| 1892 | 3,181,000 | 3,640,000 | 2,576,000 | 914,000 | 160,000 | 10,471,000 |
| 1893 | 2,866,000 | 3,692,000 | 2,551,000 | 918,000 | 220,000 | 10,247,000 |
| 1894 | 3,233,000 | 3,848,000 | 2,264,000 | 959,000 | 250,000 | 10,554,000 |
| 1895 | 3,250,000 | 4,030,000 | 2,743,000 | 1,074,000 | 300,000 | 11,397,000 |
| 1896 | 3,276,000 | 4,160,000 | 2,572,000 | 1,105,000 | 419,000 | 11,532,000 |
| 1897 | 3,224,000 | 4,368,000 | 2,738,000 | 1,004,000 | 546,000 | 11,880,000 |
| 1898 | 3,432,000 | 4,628,000 | 3,040,000 | 1,058,000 | 726,000 | 12,889,000 |
| 1899 | 3,519,000 | 4,836,000 | 3,553,000 | 1,297,000 | 845,000 | 14,050,000 |
| 1900 | 3,334,000 | 4,576,000 | 3,856,000 | 980,000 | 789,000 | 13,535,000 |

*Average value per acre of cotton in the United States, 1891–1900, by States.*

| States and Territories. | 1891–92. | 1892–93. | 1893–94. | 1894–95. | 1895–96. | 1896–97. | 1897–98. | 1898–99. | 1899–1900. |
|---|---|---|---|---|---|---|---|---|---|
| Virginia | ........ | ........ | ........ | $5.94 | $7.31 | $8.07 | $7.39 | $7.31 | $8.32 |
| North Carolina | ........ | ........ | $12.20 | 10.00 | 15.52 | 14.45 | 14.66 | 12.93 | 14.87 |
| South Carolina | ........ | ........ | 12.24 | 10.44 | 17.26 | 15.97 | 13.85 | 11.06 | 13.28 |
| Georgia | ........ | ........ | 11.97 | 9.10 | 14.25 | 12.71 | 10.82 | 10.22 | 14.61 |
| Florida | ........ | ........ | 12.17 | 6.67 | 8.28 | 7.92 | 8.67 | 9.84 | 14.66 |
| Alabama | ........ | ........ | 12.24 | 8.97 | 11.47 | 10.65 | 11.81 | 10.31 | 12.44 |
| Mississippi | ........ | ........ | 12.92 | 11.07 | 16.69 | 14.47 | 15.89 | 11.60 | 15.87 |
| Louisiana | ........ | ........ | 17.50 | 15.41 | 18.42 | 15.40 | 18.37 | 15.11 | 21.77 |
| Texas | ........ | ........ | 16.59 | 12.58 | 13.40 | 11.00 | 12.05 | 13.82 | 13.88 |
| Arkansas | ........ | ........ | 12.36 | 11.17 | 17.98 | 12.71 | 16.85 | 13.40 | 14.08 |
| Tennessee | ........ | ........ | 11.13 | 7.61 | 9.92 | 8.62 | 7.98 | 9.77 | 9.46 |
| Missouri | ........ | ........ | ........ | ........ | 10.13 | 9.96 | 9.33 | 11.00 | 15.17 |
| Oklahoma | ........ | ........ | ........ | ........ | 22.14 | 15.92 | 15.55 | 14.40 | 12.05 |
| Indian Territory | ........ | ........ | ........ | ........ | 13.22 | 21.16 | 19.94 | 18.96 | 15.16 |
| General average | ........ | ........ | 13.41 | 10.94 | 14.53 | 12.54 | 13.14 | 12.23 | 14.31 |

*Average plantation price of cotton per pound December 1, 1891–1900, by States.*

| States and Territories. | 1891. | 1892. | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. | 1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| Virginia | 7.0 | 8.6 | 7.1 | 5.0 | 7.8 | 7.1 | 6.9 | 5.9 | 7.0 | 9.2 |
| North Carolina | 7.4 | 8.6 | 7.2 | 4.8 | 8.2 | 6.7 | 7.0 | 5.9 | 7.2 | 9.4 |
| South Carolina | 7.4 | 8.6 | 7.1 | 5.0 | 8.8 | 6.8 | 6.9 | 5.6 | 7.0 | 9.5 |
| Georgia | 7.4 | 8.5 | 7.3 | 4.5 | 7.0 | 7.0 | 6.7 | 5.6 | 7.2 | 9.5 |
| Florida | 7.3 | 8.2 | 7.3 | 4.8 | 11.5 | 8.7 | 6.8 | 5.6 | 8.4 | 9.0 |
| Alabama | 7.3 | 8.5 | 7.0 | 4.8 | 7.8 | 6.5 | 6.7 | 5.7 | 7.0 | 9.3 |
| Mississippi | 7.3 | 8.5 | 7.0 | 4.1 | 7.5 | 6.7 | 6.7 | 5.7 | 7.0 | 9.4 |
| Louisiana | 7.3 | 8.4 | 7.0 | 4.3 | 7.8 | 6.7 | 6.7 | 5.7 | 6.9 | 9.2 |
| Texas | 7.0 | 8.0 | 6.9 | 4.5 | 7.3 | 6.5 | 6.6 | 5.8 | 6.8 | 8.9 |
| Arkansas | 7.3 | 8.5 | 6.8 | 4.8 | 7.6 | 6.4 | 6.5 | 5.8 | 6.9 | 9.0 |
| Tennessee | 7.3 | 8.5 | 6.5 | 4.5 | 7.3 | 6.2 | 6.6 | 5.7 | 7.5 | 9.0 |
| Missouri | ...... | 7.8 | ...... | 4.6 | 7.4 | 6.2 | 6.4 | 5.8 | 7.0 | 7.9 |
| Oklahoma | ...... | ...... | ...... | 4.6 | 7.5 | 6.2 | 6.7 | 5.8 | 6.8 | 8.7 |
| Indian Territory | ...... | ...... | ...... | ...... | 7.3 | ...... | 6.4 | 5.8 | 6.9 | 8.7 |
| General average | 7.3 | 8.4 | 7.0 | 4.6 | 7.6 | 6.6 | 6.6 | 5.7 | 7.0 | ...... |

*Acreage, production, value, prices, and exports of cotton of the United States, 1866–1899, inclusive.*

| Year. | Acreage. | Average yield per acre. | Production. | Average farm price per pound, Dec. 1. | Value. | New York closing prices per pound on middling upland. December. Low. | December. High. | May of following year. Low. | May of following year. High. | Domestic exports fiscal years beginning July 1. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Acres.* | *Bales.* | *Bales.* | *Cents.* | *Dollars.* | *Cts.* | *Cts.* | *Cts.* | *Cts.* | *Bales of 500 pounds.* |
| 1866 | [1] 6,300,000 | .33 | 2,097,254 | ...... | 204,561,896 | ...... | ...... | ...... | ...... | 1,322,947 |
| 1867 | 7,000,000 | .36 | 2,519,554 | ...... | 199,583,510 | ...... | ...... | ...... | ...... | 1,569,527 |
| 1868 | 7,000,000 | .34 | 2,366,467 | ...... | 226,794,168 | ...... | ...... | ...... | ...... | 1,288,656 |
| 1869 | 7,750,000 | .40 | 3,122,551 | 16.5 | 261,067,037 | ...... | ...... | ...... | ...... | 1,917,117 |
| 1870 | 8,680,000 | .50 | 4,352,317 | 12.1 | 292,703,086 | ...... | ...... | ...... | ...... | 2,925,856 |
| 1871 | 7,378,000 | .40 | 2,974,351 | 17.9 | 242,672,804 | ...... | ...... | $23\frac{1}{2}$ | $24\frac{7}{8}$ | 1,867,075 |
| 1872 | 8,500,000 | .46 | 3,930,508 | 16.5 | 280,552,629 | $19\frac{1}{8}$ | $20\frac{1}{4}$ | $19\frac{1}{4}$ | $19\frac{5}{8}$ | 2,400,125 |
| 1873 | 9,350,000 | .45 | 4,170,388 | 14.1 | 289,853,486 | $15\frac{5}{8}$ | $16\frac{1}{2}$ | $17\frac{3}{4}$ | $18\frac{7}{8}$ | 2,717,205 |
| 1874 | 10,982,000 | .35 | 3,832,991 | 13.0 | 228,113,080 | $14\frac{1}{8}$ | $14\frac{7}{8}$ | $16\frac{1}{8}$ | $16\frac{3}{8}$ | 2,520,838 |
| 1875 | 10,803,030 | .43 | 4,632,313 | 11.1 | 233,109,945 | $13\frac{1}{16}$ | $13\frac{5}{16}$ | $11\frac{13}{16}$ | $13\frac{1}{8}$ | 2,982,811 |
| 1876 | 11,677,250 | .38 | 4,474,069 | 9.9 | 211,655,041 | $12\frac{1}{16}$ | $12\frac{1}{2}$ | $10\frac{13}{16}$ | $11\frac{3}{8}$ | 2,890,738 |
| 1877 | 12,600,000 | .38 | 4,773,865 | 10.5 | 235,721,194 | $11\frac{1}{4}$ | $11\frac{1}{2}$ | $10\frac{5}{8}$ | $11\frac{1}{4}$ | 3,215,067 |
| 1878 | 12,266,800 | .41 | 5,074,155 | 8.2 | 193,467,706 | $8\frac{13}{16}$ | $9\frac{1}{2}$ | $11\frac{7}{8}$ | $13\frac{3}{4}$ | 3,256,746 |
| 1879 | 12,595,500 | .46 | 5,761,252 | 10.2 | 242,140,987 | $12\frac{3}{8}$ | $13\frac{7}{16}$ | $11\frac{11}{16}$ | $11\frac{7}{8}$ | 3,644,122 |
| 1880 | 15,475,300 | .43 | 6,605,750 | 9.8 | 280,266,242 | $11\frac{7}{8}$ | 12 | $10\frac{7}{16}$ | $10\frac{7}{8}$ | 4,381,857 |
| 1881 | 16,710,730 | .33 | 5,456,048 | 10.0 | 294,135,547 | $11\frac{7}{8}$ | $12\frac{1}{8}$ | $12\frac{1}{16}$ | $12\frac{3}{8}$ | 3,479,952 |

[1] Estimated.

*Acreage, production, value, prices, and exports of cotton of the United States, 1866–1899, inclusive*—Continued.

| Year. | Acreage. | Average yield per acre. | Production. | Average farm price per pound, Dec. 1. | Value. | New York closing prices per pound on middling upland. December. Low. | December. High. | May of following year. Low. | May of following year. High. | Domestic exports fiscal years beginning July 1. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Acres.* | *Bales.* | *Bales.* | *Cents.* | *Dollars.* | *Cts.* | *Cts.* | *Cts.* | *Cts.* | *Bales of 500 pounds.* |
| 1882 | 16,791,557 | .41 | 6,949,756 | 9.9 | 309,696,500 | 10 1/4 | 10 7/16 | 10 1/2 | 11 1/8 | 4,576,150 |
| 1883 | 16,777,993 | .34 | 5,713,200 | 9.0 | 250,594,750 | 10 3/8 | 10 9/16 | 11 1/2 | 11 3/4 | 3,725,145 |
| 1884 | 17,439,612 | .33 | 5,706,165 | 9.2 | 253,993,385 | 10 7/16 | 11 7/16 | 10 11/16 | 11 | 3,783,319 |
| 1885 | 18,300,865 | .36 | 6,575,691 | 8.5 | 269,989,812 | 9 3/16 | 9 7/16 | 9 3/16 | 9 5/16 | 4,116,075 |
| 1886 | 18,454,603 | .35 | 6,505,087 | 8.1 | 309,381,938 | 9 3/16 | 9 9/16 | 10 3/4 | 11 7/16 | 4,338,915 |
| 1887 | 18,641,067 | .38 | 7,046,833 | 8.5 | 337,972,453 | 10 1/2 | 10 5/8 | 9 15/16 | 10 1/16 | 4,528,242 |
| 1888 | 19,058,591 | .36 | 6,938,290 | 8.5 | 354,454,340 | 9 3/4 | 9 7/8 | 11 | 11 3/16 | 4,769,633 |
| 1889 | 20,171,896 | .36 | 7,311,322 | 8.3 | 402,951,814 | 10 1/4 | 10 1/4 | 11 15/16 | 12 3/4 | 4,943,600 |
| 1890 | 20,809,053 | .42 | 8,652,597 | 8.6 | 369,568,858 | 9 3/16 | 9 7/16 | 8 7/8 | 8 15/16 | 5,814,717 |
| 1891 | 20,714,937 | .44 | 9,035,379 | 7.3 | 326,513,298 | 7 3/4 | 8 1/16 | 7 1/4 | 7 7/16 | 5,870,440 |
| 1892 | 18,067,924 | .37 | 6,700,365 | 8.4 | 262,252,286 | 9 3/8 | 10 | 7 5/8 | 7 13/16 | 4,424,230 |
| 1893 | 19,525,000 | .39 | 7,549,817 | 7.0 | 274,479,637 | 7 13/16 | 8 1/16 | 7 1/8 | 7 3/8 | 5,366,565 |
| 1894 | 23,687,950 | .42 | 9,901,251 | 4.6 | 287,120,818 | 5 11/16 | 5 13/16 | 6 3/4 | 7 3/8 | 7,034,866 |
| 1895 | 20,184,808 | .36 | 7,161,094 | 7.6 | 260,338,096 | 8 1/4 | 8 9/16 | 8 | 8 3/8 | 4,670,453 |
| 1896 | 23,273,209 | .37 | 8,532,705 | 6.6 | 291,811,564 | 7 1/16 | 7 11/16 | 7 5/8 | 7 13/16 | 6,207,510 |
| 1897 | 24,319,584 | .45 | 10,897,857 | 6.6 | 319,491,412 | 5 13/16 | 5 15/16 | 6 5/16 | 6 9/16 | 7,725,572 |
| 1898 | 24,967,295 | .45 | 11,189,205 | 5.7 | 305,467,041 | 5 5/8 | 5 7/8 | 6 1/8 | 6 1/4 | 7,575,838 |
| 1899 | 23,403,497 | .39 | 9,142,838 | ....... | 334,847,868 | ...... | ...... | ...... | ...... | 6,201,166 |

*Average yield per acre of cotton in the United States, 1891–1900, by States.*

| States and Territories. | 1890–91 | 1891–92 | 1892–93 | 1893–94 | 1894–95 | 1895–96 | 1896–97 | 1897–98 | 1898–99 | 1899–1900. |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Bales.* | *Bales.* | *Bales.* | *Bales.* | *Bales.* | *Bales.* | *Bales.* | *Bales.* | *Bales.* | *Bales.* |
| Virginia | ........ | ........ | ........ | ........ | 0.21 | 0.18 | 0.24 | 0.25 | 0.27 | 0.23 |
| North Carolina | ........ | ........ | ........ | 0.34 | .35 | .38 | .42 | .50 | .48 | .41 |
| South Carolina | ........ | ........ | ........ | .34 | .38 | .42 | .46 | .50 | .44 | .38 |
| Georgia | ........ | ........ | ........ | .33 | .33 | .35 | .37 | .38 | .39 | .41 |
| Florida | ........ | ........ | ........ | .33 | .24 | .20 | .18 | .21 | .23 | .28 |
| Alabama | ........ | ........ | ........ | .35 | .32 | .28 | .31 | .41 | .39 | .35 |
| Mississippi | ........ | ........ | ........ | .37 | .41 | .41 | .42 | .55 | .43 | .43 |
| Louisiana | ........ | ........ | ........ | .50 | .55 | .45 | .46 | .63 | .56 | .59 |
| Texas | ........ | ........ | ........ | .48 | .45 | .33 | .31 | .39 | .48 | .37 |
| Arkansas | ........ | ........ | ........ | .36 | .48 | .44 | .39 | .58 | .49 | .39 |
| Tennessee | ........ | ........ | ........ | .34 | .33 | .24 | .26 | .28 | .36 | .26 |
| Missouri | ........ | ........ | ........ | ........ | .38 | .25 | .31 | .32 | .40 | .42 |
| Oklahoma | ........ | ........ | ........ | ........ | .45 | .54 | .45 | .51 | .50 | .32 |
| Indian Territory | ........ | ........ | ........ | ........ | .45 | .32 | .62 | .65 | .66 | .40 |
| General average | .416 | .436 | .371 | .387 | .418 | .355 | .367 | .448 | .448 | .391 |

*Food constituents of cotton-seed meal.*

| | Fresh, or air-dry, material. Water. | Ash. | Protein. | Fiber. | Nitrogen-free extract. | Fat. |
|---|---|---|---|---|---|---|
| | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* | *Per cent.* |
| Minimum | 5.29 | 1.72 | 23.27 | 1.88 | 9.13 | 2.18 |
| Maximum | 18.52 | 10.62 | 52.88 | 15.15 | 38.68 | 20.66 |
| Average | 8.52 | 7.02 | 43.26 | 5.44 | 22.31 | 13.45 |

*Wholesale prices upland middling cotton per pound, in leading cities of the United States, 1896–1900.*

| Date. | New York. | | New Orleans. | | Memphis. | | Galveston. | | Savannah. | | Charleston. | | Wilmington. | | Norfolk. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| January | 8 3/16 | 8 3/8 | 7 13/16 | 8 | 7 3/4 | 8 | 7 13/16 | 8 1/16 | 7 5/8 | 7 15/16 | 7 5/8 | 7 3/4 | 7 3/4 | 7 7/8 | 7 13/16 | 8 |
| February | 7 13/16 | 8 1/4 | 7 1/2 | 8 | 7 1/2 | 7 15/16 | 7 9/16 | 8 | 7 7/16 | 7 3/4 | 7 3/8 | 7 3/4 | 7 1/2 | 7 7/8 | 7 9/16 | 7 15/16 |
| March | 7 5/8 | 8 | 7 3/8 | 7 13/16 | 7 3/8 | 7 3/4 | 7 3/8 | 7 13/16 | 7 5/16 | 7 7/8 | 7 1/4 | 7 1/2 | 7 3/8 | 7 1/2 | 7 3/8 | 7 3/4 |
| April | 7 7/8 | 8 1/8 | 7 5/8 | 7 3/4 | 7 1/2 | 7 9/16 | 7 11/16 | 7 3/4 | 7 1/2 | 7 5/8 | 7 1/2 | 7 1/2 | 7 1/2 | 7 3/4 | 7 5/8 | 7 3/4 |
| May | 8 | 8 3/8 | 7 3/8 | 7 3/4 | 7 7/16 | 7 9/16 | 7 7/16 | 7 7/8 | 7 1/2 | 7 3/4 | 7 1/2 | 7 5/8 | 7 5/8 | 7 7/8 | 7 1/2 | 7 15/16 |
| June | 7 7/16 | 8 | 6 13/16 | 7 3/8 | 7 | 7 5/8 | 6 5/8 | 7 3/8 | 7 | 7 1/2 | 6 5/8 | 7 1/2 | 7 1/8 | 7 1/2 | 7 1/8 | 7 1/4 |
| July | 7 1/16 | 7 7/16 | 6 1/2 | 6 13/16 | 6 5/8 | 6 7/8 | 6 3/8 | 6 9/16 | 6 5/8 | 7 | 6 3/8 | 6 5/8 | 7 | 7 1/8 | 6 3/4 | 7 1/8 |
| August | 7 7/16 | 8 5/8 | 6 13/16 | 8 | 6 3/4 | 7 7/8 | 6 1/2 | 8 | 6 5/8 | 7 11/16 | 6 5/8 | 7 11/16 | 7 1/4 | 7 1/2 | 6 3/4 | 7 3/4 |
| September | 8 3/16 | 8 7/8 | 7 1/2 | 8 1/8 | 7 3/8 | 8 1/16 | 7 1/4 | 8 1/4 | 7 1/8 | 7 15/16 | 7 1/4 | 8 | 7 1/2 | 8 | 7 1/2 | 8 1/4 |
| October | 7 15/16 | 8 3/8 | 7 1/8 | 7 5/8 | 7 1/8 | 7 5/8 | 7 1/4 | 7 3/4 | 7 | 7 1/2 | 7 | 7 1/2 | 7 1/4 | 7 3/4 | 7 1/4 | 7 7/8 |
| November | 7 5/8 | 8 3/16 | 7 3/16 | 7 1/2 | 7 1/8 | 7 7/16 | 7 1/4 | 7 9/16 | 6 7/8 | 7 3/8 | 6 7/8 | 7 1/4 | 7 | 7 9/16 | 7 3/16 | 7 9/16 |
| December | 7 1/16 | 7 11/16 | 6 11/16 | 7 3/8 | 6 11/16 | 7 3/16 | 6 11/16 | 7 5/16 | 6 7/16 | 7 | 6 1/2 | 7 | 6 7/16 | 7 1/8 | 6 11/16 | 7 1/4 |
| **1897.** | | | | | | | | | | | | | | | | |
| January | 7 1/16 | 7 5/16 | 6 7/8 | 7 | 6 3/4 | 6 15/16 | 6 13/16 | 7 | 6 9/16 | 6 7/8 | 6 9/16 | 7 | 6 5/8 | 6 7/8 | 6 3/4 | 6 15/16 |
| February | 7 | 7 7/16 | 6 11/16 | 7 3/16 | 6 3/4 | 7 | 6 3/4 | 7 1/8 | 6 5/8 | 7 | 6 1/2 | 7 | 6 3/4 | 6 7/8 | 6 13/16 | 7 1/16 |
| March | 7 3/16 | 7 7/16 | 6 15/16 | 7 3/16 | 6 7/8 | 7 1/16 | 7 | 7 1/4 | 6 3/4 | 7 | 6 7/8 | 7 | 6 7/8 | 7 | 7 | 7 3/16 |
| April | 7 5/16 | 7 3/4 | 6 15/16 | 7 9/16 | 6 15/16 | 7 3/8 | 7 | 7 1/2 | 6 7/8 | 7 3/8 | 6 15/16 | 7 3/8 | 7 | 7 3/8 | 7 3/16 | 7 7/16 |
| May | 7 5/8 | 7 13/16 | 7 3/8 | 7 9/16 | 7 1/4 | 7 3/8 | 7 1/4 | 7 1/2 | 7 3/8 | 7 1/2 | 7 1/4 | 7 3/8 | 7 3/8 | 7 1/2 | 7 1/2 | 7 5/8 |
| June | 7 11/16 | 7 7/8 | 7 3/8 | 7 5/8 | 7 3/16 | 7 1/2 | 7 1/4 | 7 5/8 | 7 1/4 | 7 1/2 | 7 1/4 | 7 1/2 | 7 1/2 | 7 5/8 | 7 1/2 | 7 3/4 |
| July | 7 7/8 | 8 | 7 5/8 | 7 13/16 | 7 1/2 | 7 13/16 | 7 5/8 | 7 11/16 | 7 1/2 | 7 3/4 | 7 1/2 | 7 3/4 | 7 5/8 | 8 1/8 | 7 3/4 | 8 1/8 |
| August | 7 7/8 | 8 1/4 | 7 1/16 | 7 11/16 | 7 7/16 | 7 13/16 | 7 1/8 | 7 5/8 | 7 | 7 3/4 | 7 | 7 3/4 | 7 | 8 1/8 | 8 | 8 1/8 |
| September | 6 1/2 | 7 13/16 | 6 1/16 | 7 1/16 | 6 | 7 7/16 | 6 1/4 | 7 1/8 | 5 13/16 | 7 | 5 13/16 | 7 | 6 | 7 | 6 3/16 | 8 |
| October | 6 | 6 1/2 | 5 1/2 | 6 1/8 | 5 1/2 | 6 1/16 | 5 11/16 | 6 3/8 | 5 3/8 | 5 15/16 | 5 3/8 | 6 | 5 1/2 | 6 1/8 | 5 9/16 | 6 1/4 |
| November | 5 13/16 | 6 | 5 1/4 | 5 1/2 | 5 1/4 | 5 7/8 | 5 3/8 | 5 5/8 | 5 1/8 | 5 5/16 | 5 1/8 | 5 5/16 | 5 3/16 | 5 1/2 | 5 3/8 | 5 9/16 |
| December | 5 13/16 | 5 15/16 | 5 1/4 | 5 3/8 | 5 1/4 | 5 5/16 | 5 3/8 | 5 1/2 | 5 1/8 | 5 3/16 | 5 3/16 | 5 3/16 | 5 | 5 1/2 | 5 1/2 | 5 1/2 |
| **1898.** | | | | | | | | | | | | | | | | |
| January | 5 7/8 | 5 15/16 | 5 3/16 | 5 3/8 | 5 5/16 | 5 3/8 | 5 7/16 | 5 9/16 | 5 1/8 | 5 1/4 | 5 3/16 | 5 5/16 | 5 3/8 | 5 7/16 | 5 7/16 | 5 1/2 |
| February | 5 15/16 | 6 5/16 | 5 1/4 | 5 11/16 | 5 5/16 | 5 3/4 | 5 1/2 | 6 | 5 3/16 | 5 15/16 | 5 1/4 | 5 3/4 | 5 3/8 | 5 3/4 | 5 1/2 | 5 15/16 |
| March | 6 1/16 | 6 5/16 | 5 7/16 | 5 3/4 | 5 1/2 | 5 13/16 | 5 5/8 | 6 1/16 | 5 9/16 | 5 3/4 | 5 1/2 | 5 3/4 | 5 3/4 | 6 | 5 3/4 | 6 |
| April | 6 3/16 | 6 7/8 | 5 9/16 | 5 13/16 | 5 1/2 | 6 | 5 3/4 | 5 7/8 | 5 9/16 | 5 7/8 | 5 9/16 | 5 13/16 | 5 5/8 | 6 1/4 | 5 13/16 | 6 3/16 |
| May | 6 5/16 | 6 9/16 | 5 11/16 | 6 1/16 | 5 3/4 | 6 | 5 11/16 | 6 | 5 11/16 | 6 | 5 3/4 | 5 3/4 | 6 | 6 1/4 | 6 1/8 | 6 3/8 |
| June | 6 5/16 | 6 9/16 | 5 15/16 | 6 1/16 | 5 7/8 | 6 | 6 13/16 | 6 | 5 3/4 | 6 | 6 | 6 | 5 7/8 | 6 1/8 | 6 3/16 | 6 3/8 |
| July | 6 1/16 | 6 1/4 | 5 3/8 | 5 15/16 | 5 3/4 | 5 7/8 | 5 11/16 | 5 13/16 | 5 5/8 | 5 3/4 | 5 1/2 | 5 1/2 | 5 5/8 | 5 7/8 | 5 7/8 | 6 1/8 |
| August | 5 3/4 | 6 1/8 | 5 5/8 | 5 11/16 | 5 3/8 | 5 3/4 | 5 7/16 | 5 11/16 | 5 1/8 | 5 11/16 | 5 | 5 1/2 | 5 1/4 | 5 5/8 | 5 5/8 | 5 7/8 |
| September | 5 5/16 | 5 13/16 | 4 7/8 | 5 3/8 | 4 7/8 | 5 5/16 | 4 7/8 | 5 7/16 | 4 3/4 | 5 3/16 | 4 3/4 | 5 1/8 | 4 7/8 | 5 1/4 | 5 1/8 | 5 5/8 |
| October | 5 5/16 | 5 1/2 | 4 7/8 | 5 1/4 | 4 7/8 | 5 | 4 7/8 | 6 1/16 | 4 5/8 | 4 13/16 | 4 11/16 | 4 7/8 | 4 7/8 | 5 | 5 | 5 1/8 |
| November | 5 5/16 | 5 3/4 | 4 3/4 | 5 1/16 | 4 7/8 | 5 3/16 | 4 7/8 | 5 1/4 | 4 1/2 | 4 7/8 | 4 9/16 | 4 15/16 | 4 3/4 | 5 | 4 15/16 | 5 1/4 |
| December | 5 5/8 | 5 7/8 | 5 | 5 1/4 | 5 1/4 | 5 3/8 | 5 1/4 | 5 1/2 | 4 7/8 | 5 1/8 | 4 15/16 | 5 1/4 | 5 | 5 3/8 | 5 1/4 | 5 7/16 |

*Wholesale prices upland middling cotton, per pound, in leading cities of the United States, 1896–1900*—Continued.

| Date. | New York. | | New Orleans. | | Memphis. | | Galveston. | | Savannah. | | Charleston. | | Wilmington. | | Norfolk. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1899.** | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| January | 5 7/8 | 6 7/16 | 5 3/16 | 5 3/4 | 5 3/8 | 5 3/4 | 5 7/16 | 6 1/16 | 5 1/16 | 5 3/4 | 5 1/8 | 5 3/4 | 5 3/8 | 5 7/8 | 5 3/8 | 6 |
| February | 6 5/16 | 6 5/8 | 5 11/16 | 6 | 5 11/16 | 6 1/8 | 6 | 6 3/8 | 5 5/8 | 5 15/16 | 5 11/16 | 5 15/16 | 5 7/8 | 6 | 6 | 6 1/4 |
| March | 6 3/16 | 6 9/16 | 5 11/16 | 6 1/3 | 5 7/8 | 6 1/8 | 5 15/16 | 6 1/4 | 5 11/16 | 5 7/8 | 5 5/8 | 5 15/16 | 6 | 6 | 6 | 6 1/8 |
| April | 6 1/8 | 6 5/16 | 5 5/8 | 5 3/4 | 5 3/4 | 5 7/8 | 5 7/8 | 5 15/16 | 5 5/8 | 5 11/16 | 5 1/2 | 5 5/8 | 5 7/8 | 6 | 5 7/8 | 6 |
| May | 6 1/8 | 6 1/4 | 5 11/16 | 5 7/8 | 5 3/4 | 5 3/4 | 5 7/8 | 5 15/16 | 5 5/8 | 5 5/8 | 5 1/2 | 5 9/16 | 5 7/8 | 5 7/8 | 5 7/8 | 6 |
| June | 6 1/16 | 6 5/16 | 5 1/2 | 5 3/4 | 5 5/8 | 5 13/16 | 5 3/4 | 5 15/16 | 5 5/8 | 5 5/8 | 6 9/16 | 6 5/8 | 5 7/8 | 5 7/8 | 5 7/8 | 6 1/8 |
| July | 6 1/8 | 6 1/4 | 5 5/8 | 5 3/4 | 5 5/8 | 5 3/4 | 5 7/8 | 5 7/8 | 5 5/8 | 5 5/8 | ... | ... | 5 7/8 | 5 7/8 | 5 7/8 | 6 |
| August | 6 1/8 | 6 1/2 | 5 3/4 | 5 15/16 | 5 3/4 | 5 15/16 | 5 7/8 | 6 1/8 | 5 1/2 | 5 7/8 | 5 1/2 | 5 11/16 | 5 7/8 | 5 7/8 | 5 15/16 | 6 1/8 |
| September | 6 1/4 | 6 7/8 | 5 3/4 | 6 1/2 | 5 7/8 | 6 3/4 | 6 1/16 | 6 5/8 | 5 5/8 | 6 1/2 | 5 1/2 | 6 5/8 | 5 7/8 | 6 1/2 | 6 | 6 7/8 |
| October | 7 3/16 | 7 3/8 | 6 1/2 | 6 15/16 | 6 3/4 | 7 1/8 | 6 15/16 | 7 1/8 | 6 5/8 | 6 7/8 | 6 5/8 | 7 | 6 1/2 | 7 1/4 | 7 1/16 | 7 3/16 |
| November | 7 3/8 | 7 13/16 | 6 7/8 | 7 7/16 | 7 | 7 1/2 | 7 1/16 | 7 1/2 | 6 7/8 | 7 1/4 | 6 7/8 | 7 3/8 | 7 1/8 | 7 1/2 | 7 1/16 | 7 1/2 |
| December | 7 1/2 | 7 3/4 | 7 3/16 | 7 1/2 | 7 1/4 | 7 7/16 | 7 1/4 | 7 7/16 | 7 1/8 | 7 5/16 | 7 3/16 | 7 3/8 | 7 | 7 1/4 | 7 5/16 | 7 1/2 |
| **1900.** | | | | | | | | | | | | | | | | |
| January | 7 1/4 | 8 | 7 1/4 | 7 3/4 | 7 3/8 | 7 11/61 | 7 1/4 | 7 11/16 | 7 5/16 | 7 5/8 | 7 1/4 | 7 5/8 | 7 1/4 | 7 1/2 | 7 7/16 | 7 7/8 |
| February | 8 1/8 | 9 5/16 | 7 7/8 | 8 7/8 | 7 11/16 | 8 3/4 | 7 3/4 | 8 13/16 | 7 11/16 | 8 15/16 | 7 5/8 | 8 3/4 | 7 1/8 | 8 3/4 | 7 7/8 | 9 1/8 |
| March | 9 7/16 | 9 7/8 | 9 | 9 7/16 | 8 7/8 | 9 7/16 | 9 1/8 | 9 5/8 | 9 1/16 | 9 1/2 | 9 | 9 1/2 | 9 | 9 1/2 | 9 1/4 | 9 7/8 |
| April | 9 9/16 | 9 7/8 | 9 1/8 | 9 1/2 | 9 1/4 | 9 3/8 | 9 1/4 | 9 7/16 | 9 3/8 | 9 7/16 | 9 1/4 | 9 3/8 | 9 1/4 | 9 1/2 | 9 1/2 | 9 5/8 |
| May | 9 | 9 7/8 | 8 13/16 | 9 1/2 | 8 3/4 | 9 7/16 | 8 7/8 | 9 7/16 | 9 | 9 7/16 | 9 5/16 | 9 3/8 | 9 1/4 | 9 1/4 | 9 1/4 | 9 5/8 |
| June | 8 3/4 | 9 5/8 | 8 13/16 | 10 | 8 5/8 | 9 5/8 | 8 1/2 | 9 3/8 | 8 3/4 | 9 1/4 | ... | ... | ... | ... | 8 3/4 | 9 5/6 |
| July | 9 13/16 | 10 1/4 | 9 7/8 | 10 1/4 | 9 5/8 | 10 | 9 3/8 | 9 1/2 | 9 5/16 | 9 7/8 | 9 1/2 | 9 5/8 | ... | ... | 9 3/4 | 10 1/16 |
| August | 9 1/2 | 10 1/4 | 9 1/2 | 10 1/4 | 9 1/2 | 9 3/4 | 8 7/8 | 9 9/16 | 9 | 9 3/4 | 8 5/8 | 9 1/2 | ... | ... | 9 1/4 | 10 |
| September | 9 5/8 | 11 | 9 1/2 | 11 1/8 | 9 5/16 | 11 | 9 1/4 | 10 | 9 1/16 | 10 3/4 | 8 7/8 | 10 3/4 | 9 | 10 3/4 | 9 3/8 | 11 |
| October | 9 1/4 | 11 | 8 13/16 | 10 1/4 | 8 7/8 | 10 3/16 | 8 7/8 | 10 | 8 13/16 | 10 1/16 | 8 3/4 | 10 | 9 | 10 1/4 | 9 | 10 5/16 |
| November | 9 9/16 | 10 1/4 | 9 | 9 7/8 | 8 15/16 | 10 | 9 | 9 3/4 | 8 15/16 | 9 3/4 | 9 | 9 11/16 | 9 | 9 5/8 | 9 | 9 13/16 |
| December | 9 3/4 | 10 5/16 | 9 1/4 | 9 13/16 | 9 3/8 | 9 13/16 | 9 1/4 | 9 11/16 | 9 1/16 | 9 11/16 | 9 | 9 5/8 | 9 1/4 | 9 5/8 | 9 1/4 | 9 3/4 |

## HOPS.

The hop crop of the world reported for 1899, a total of 1,286,460 bales, was the largest in five years, and the crop of the United States the largest since that of 1895, which was 55,000 bales greater. The New York production has steadily declined, until it is now little more than half what it was in 1895, while the Pacific Coast production has increased.

Exports have been about the same, except in 1897, when there was a heavy decrease, and in 1899 when an increase of over 3,000,000 pounds was noted. The wholesale price has been quite steady since a sharp gain was made in November and December, 1895. Declines are found, however, in the summers of 1897 and 1900.

*Hop crop of the countries named, 1895–1899.*

[In bales of 180 pounds.]

| Countries. | 1895. | 1896. | 1897. | 1898. | 1899. |
|---|---|---|---|---|---|
| California | 52,000 | 35,000 | 45,000 | 44,500 | 59,000 |
| Oregon | 99,500 | 56,000 | 75,000 | 71,250 | 82,300 |
| Washington | 28,800 | 12,000 | 32,000 | 36,200 | 36,000 |
| New York | 110,000 | 75,000 | 75,000 | 65,000 | 58,000 |
| Total United States | 290,300 | 178,000 | 227,000 | 216,950 | 235,300 |
| Australia [1] | ........ | 5,476 | 7,162 | 6,560 | 7,597 |
| Austria | 95,378 | 121,876 | 77,896 | 76,774 | 132,753 |
| Hungary | ........ | ........ | ........ | 3,369 | 3,383 |
| Belgium | 99,880 | ........ | 83,020 | 30,630 | [2] 70,311 |
| England | 344,335 | 281,983 | 255,787 | 222,018 | 411,521 |
| France | 41,966 | 38,647 | 44,101 | 37,411 | 48,427 |
| Germany | 369,654 | 310,178 | 292,247 | 267,825 | 336,111 |
| Russia | ........ | ........ | 64,000 | 61,240 | 41,057 |
| Total | 1,241,513 | 936,160 | 1,051,213 | 922,777 | 1,286,460 |

[1] Victoria and Tasmania only. [2] Includes Holland.

*Wholesale prices of hops per pound in leading cities of the United States, 1896–1900.*

| Date. | New York. Choice State. Low. | New York. Choice State. High. | Cincinnati. Choice. Low. | Cincinnati. Choice. High. | Chicago. Pacific coast, common to choice. Low. | Chicago. Pacific coast, common to choice. High. |
|---|---|---|---|---|---|---|
| **1896.** | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| January | 8 | 9 | 7 | 9 | 5 | 8 |
| February | 7½ | 8 | 7 | 8 | 5 | 8 |
| March | 7½ | 8 | 6 | 8 | 5 | 7 |
| April | 7½ | 8 | 6 | 7½ | 5 | 7 |
| May | 7 | 7½ | 6 | 7½ | 5 | 7 |
| June | 7½ | 7½ | 6 | 7 | 5 | 7 |
| July | 7 | 7½ | 6 | 7 | 5 | 7 |
| August | 7 | 7 | 6 | 7 | 4 | 7 |
| September | 7 | 9 | 6 | 7 | 4 | 7 |
| October | 9 | 11 | 10 | 12 | 6 | 10 |
| November | 10½ | 15 | 12 | 15 | 11 | 14 |
| December | 13 | 14 | 14 | 15 | 11 | 14 |
| **1897.** | | | | | | |
| January | 13 | 13½ | 13 | 13½ | 11 | 14 |
| February | 12 | 13 | 13 | 13½ | 11 | 14 |
| March | 10½ | 12 | 11 | 12½ | 10 | 13 |
| April | 9½ | 10 | 10 | 10½ | 9 | 12 |
| May | 8 | 9½ | 9 | 10 | 7 | 12 |
| June | 8 | 8 | 9 | 9 | 8 | 11 |
| July | 7 | 8 | 9 | 9 | 8 | 11 |
| August | 7 | 7 | 8 | 9 | 6 | 10 |
| September | 7 | 15 | 8 | 16 | 8 | 11 |
| October | 14 | 15 | 16 | 16 | 15 | 17 |
| November | 15 | 17 | 16 | 18 | 10 | 17 |
| December | 16 | 18 | 18 | 18 | 12 | 17 |

*Wholesale prices of hops per pound in leading cities of the United States, 1896–1900*—Continued.

| Date. | New York. | | Cincinnati. | | Chicago. | |
|---|---|---|---|---|---|---|
| | Choice State. | | Choice. | | Pacific coast, common to choice. | |
| | Low. | High. | Low. | High. | Low. | High. |
| **1898.** | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| January | 18 | 19 | 16 | 16 | 10 | 17 |
| February | 18 | 19 | 16 | 16 | 10 | 17 |
| March | 17 | 18 | 16 | 16 | 10 | 17 |
| April | 15 | 17 | 15 | 15 | 10 | 16 |
| May | 12 | 15 | 16 | 16 | 10 | 14 |
| June | 12 | 13 | 15 | 15½ | 10 | 13 |
| July | 11 | 12 | 14 | 15 | 8 | 10 |
| August | 11 | 12 | 14 | 14 | 5 | 10 |
| September | 11 | 15 | 14 | 14 | 5 | 10 |
| October | 15 | 19 | 14 | 19 | 16 | 18 |
| November | 18 | 20 | 20 | 20 | 15 | 19½ |
| December | 18 | 20 | 19 | 19 | 16 | 19 |
| **1899.** | | | | | | |
| January | 18 | 18 | 19 | 19 | 15 | 18 |
| February | 18 | 18 | 18 | 19 | 12 | 18 |
| March | 17 | 18 | 18 | 19 | 13 | 18 |
| April | 15 | 17 | 18 | 18½ | 13 | 18 |
| May | 16 | 16 | 16½ | 18 | 12 | 18 |
| June | 15 | 16 | 16 | 18 | 12 | 18 |
| July | 15 | 16 | 16 | 18 | 12 | 18 |
| August | 14 | 15 | 16 | 17 | 12 | 18 |
| September | 12 | 13 | 16 | 16 | 12½ | 16 |
| October | 13 | 15 | 13 | 13 | 9 | 16 |
| November | 13 | 14 | 13½ | 13½ | 9 | 13 |
| December | 12½ | 14 | 13 | 13 | 7 | 13 |
| **1900.** | | | | | | |
| January | 12½ | 13½ | 13 | 13 | ........ | ........ |
| February | 12½ | 13½ | 13 | 13 | ........ | ........ |
| March | 12½ | 13½ | 12½ | 12½ | ........ | ........ |
| April | 12½ | 13½ | 12½ | 12½ | ........ | ........ |
| May | 12½ | 14 | 10 | 10 | ........ | ........ |
| June | 13 | 14 | 10 | 10 | ........ | ........ |
| July | 13 | 14 | 10 | 10 | ........ | ........ |
| August | 13 | 15 | 10 | 10 | ........ | ........ |
| September | 13 | 15 | 16½ | 16½ | ........ | ........ |
| October | 17 | 21 | 16½ | 16½ | ........ | ........ |
| November | 20 | 21 | 17½ | 17½ | ........ | ........ |
| December | 18 | 21 | 18 | 18 | ........ | ........ |

## FLAXSEED.

The production of flax in this country so far as reported is for the seed only. The world's product of flaxseed in 1899 was 68,553,000 bushels, of which the United States supplied 29,601,000 bushels, an increase of 4,950,000 bushels over 1898 and of 11,000,000 bushels over 1897. The exports in 1899 amounted to 2,830,991 bushels.

The reported production of flax fiber for the world in 1899 amounted to 1,293,943,000 pounds, a decrease of 557,000,000 pounds as compared with 1898. The United States imported 10,415 tons, valued $1,783,628, the top figures of a steady increase which has been in progress since 1895.

The wholesale prices of flaxseed have increased steadily on United States markets for the past five years. The lowest figures in the Chicago list are 63¼ cents per bushel in September, 1896; the highest $1.86 in October, 1900.

*Flax crop of the countries named, 1897–1899.*

| Countries. | Seed. | | | Fiber. | | |
|---|---|---|---|---|---|---|
| | 1897. | 1898. | 1899. | 1897. | 1898. | 1899. |
| | *Bushels.* | *Bushels.* | *Bushels.* | *Pounds.* | *Pounds.* | *Pounds.* |
| United States [1] | 11,000,000 | 17,217,000 | 20,086,000 | ............ | ............ | ............ |
| Manitoba | 255,500 | 361,000 | 315,000 | ............ | ............ | ............ |
| Mexico | 258,000 | 73,000 | [1]200,000 | ............ | ............ | ............ |
| Argentina [1] | 7,000,000 | 7,000,000 | 9,000,000 | ............ | ............ | ............ |
| Total America | 18,513,500 | 24,651,000 | 29,601,000 | ............ | ............ | ............ |
| Ireland | ............ | ............ | ............ | 16,290,000 | 15,062,000 | 16,034,000 |
| Sweden | 73,500 | 72,500 | [3]72,000 | 3,917,000 | 3,644,000 | *c*3,900,000 |
| Netherlands | 275,000 | 176,000 | [3]254,000 | 11,503,000 | 10,208,000 | *c*11,169,000 |
| Belgium | 350,000 | 407,000 | [3]383,000 | 30,123,000 | 35,386,000 | *c*32,309,000 |
| France | 524,000 | 357,000 | 345,000 | 41,224,000 | 25,126,000 | 27,834,000 |
| Italy [2] | ............ | ............ | ............ | 41,917,000 | 41,917,000 | 41,917,000 |
| Austria | 724,000 | 802,000 | 735,500 | 88,195,000 | 88,833,000 | 92,067,000 |
| Hungary | 220,000 | 250,000 | 240,500 | 10,629,000 | 14,939,000 | 12,821,000 |
| Croatia-Slavonia | 58,000 | 51,000 | 26,500 | 9,816,000 | 10,325,000 | 7,921,000 |
| Total Austria-Hungary | 1,002,000 | 1,103,000 | 1,002,500 | 108,640,000 | 114,097,000 | 112,809,000 |
| Roumania | 676,000 | 461,000 | 34,500 | ............ | ............ | ............ |
| Bulgaria | 30,000 | 34,000 | 1,000 | 3,000,000 | 3,321,000 | 27,000 |
| Servia [4] | 11,000 | 11,000 | 11,000 | 1,156,000 | 1,156,000 | 1,156,000 |
| Russia | 27,296,500 | 28,537,500 | 18,022,000 | 1,240,284,000 | 1,530,776,000 | 876,788,000 |
| Total Europe | 30,238,000 | 31,159,000 | 20,125,000 | 1,498,054,000 | 1,780,693,000 | 1,123,943,000 |
| British India | 8,839,500 | 17,115,000 | 11,827,000 | ............ | ............ | ............ |
| Algeria | 5,500 | 13,500 | 7,000 | ............ | ............ | ............ |

RECAPITULATION.

| | | | | | | |
|---|---|---|---|---|---|---|
| America | 18,513,500 | 24,651,000 | 29,601,000 | ............ | ............ | ............ |
| Europe | 30,238,000 | 31,159,000 | 20,125,000 | 1,498,054,000 | 1,780,693,000 | 1,123,943,000 |
| British India | 8,839,500 | 17,115,000 | 11,827,000 | ............ | ............ | ............ |
| Algeria | 5,500 | 13,500 | 7,000 | ............ | ............ | ............ |
| Total | 57,596,500 | 72,938,500 | 61,560,000 | 1,498,054,000 | 1,780,693,000 | 1,123,943,000 |

[1] Commercial estimate.
[2] Average, 1892 to 1895.
[3] Average, 1896 to 1898.
[4] 1897 figures.

*Wholesale prices of flaxseed per bushel in leading cities of the United States, 1896–1900.*

| Date. | Cincinnati. | | Chicago. No. 1. | | Milwaukee. | |
|---|---|---|---|---|---|---|
| | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| January | 90 | 90 | 89 | 93½ | 91 | 93 |
| February | 90 | 90 | 89 | 92½ | 90 | 92¾ |
| March | 90 | 90 | 87 | 90½ | 89 | 90¼ |
| April | 90 | 90 | 88 | 92½ | 88 | 92 |
| May | 90 | 90 | 81 | 99½ | 83 | 91 |
| June | 80 | 90 | 78½ | 82½ | 76 | 82⅛ |
| July | 80 | 80 | 70½ | 76 | 70 | 76 |
| August | 65 | 80 | 63½ | 73¼ | 63½ | 73 |
| September | 65 | 70 | 63¼ | 78½ | 63½ | 78 |
| October | 65 | 70 | 68½ | 79¾ | 69½ | 78 |
| November | 65 | 70 | 70¼ | 79½ | 71 | 79⅛ |
| December | 65 | 70 | 71½ | 79½ | 73½ | 79 |
| **1897.** | | | | | | |
| January | 65 | 70 | 73 | 78¼ | 75 | 78 |
| February | 65 | 70 | 73¾ | 77¾ | 75½ | 77⅛ |
| March | 65 | 70 | 75¾ | 81¾ | 78 | 81⅛ |

*Wholesale prices of flaxseed per bushel in leading cities of the United States, 1896–1900*—Continued.

| Date. | Cincinnati. | | Chicago. | | Milwaukee. | |
|---|---|---|---|---|---|---|
| | | | No. 1. | | | |
| | Low. | High. | Low. | High. | Low. | High. |
| **1897.** | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| April | 65 | 70 | 71½ | 80 | 75 | 80 |
| May | 65 | 70 | 76 | 79¾ | 76½ | 79 |
| June | 65 | 70 | 75 | 80 | 76 | 80½ |
| July | 65 | 70 | 77 | 89 | 77½ | 89 |
| August | 65 | 75 | 87¾ | 120 | 88½ | 120 |
| September | 70 | 85 | 96¾ | 109 | 98 | 109½ |
| October | 80 | 85 | 91 | 107½ | 91 | 108 |
| November | 80 | 85 | 102 | 110½ | 106½ | 111 |
| December | 80 | 85 | 104½ | 122½ | 109 | 122¼ |
| **1898.** | | | | | | |
| January | 85 | 90 | 116 | 132 | 119½ | 132 |
| February | 85 | 90 | 122 | 130½ | 125½ | 130½ |
| March | 85 | 90 | 117 | 125½ | 118 | 125¼ |
| April | 85 | 90 | 116½ | 131½ | 118½ | 131 |
| May | 85 | 90 | 123 | 139 | 126 | 139 |
| June | 85 | 90 | 105 | 122 | 105½ | 122½ |
| July | 85 | 90 | 86½ | 107 | 90 | 104½ |
| August | 80 | 85 | 86 | 93 | 88 | 93 |
| September | 80 | 80 | 86½ | 93 | 89 | 92¾ |
| October | 80 | 80 | 89 | 107 | 90½ | 107 |
| November | 80 | 90 | 97 | 108½ | 98 | 108 |
| December | 90 | 90 | 97¾ | 118 | 103½ | 119 |
| **1899.** | | | | | | |
| January | 90 | 90 | 110½ | 120 | 115 | 120 |
| February | 90 | 90 | 113½ | 120½ | 118 | 120½ |
| March | 90 | 100 | 114 | 125 | 118 | 124½ |
| April | 100 | 100 | 112 | 125 | 117 | 125 |
| May | 90 | 100 | 102 | 117½ | 103½ | 117½ |
| June | 90 | 90 | 100½ | 110 | 103 | 109 |
| July | 90 | 90 | 97 | 104½ | 99 | 105 |
| August | 90 | 90 | 96½ | 120 | 100 | 120 |
| September | 90 | 90 | 104½ | 121 | 106 | 120 |
| October | 90 | 100 | 114 | 132½ | 114 | 132½ |
| November | 100 | 100 | 128½ | 139¼ | 126½ | 139 |
| December | 100 | 100 | 139 | 151 | 139 | 152 |
| **1900.** | | | | | | |
| January | 100 | 100 | 148 | 156 | 142 | 156 |
| February | 100 | 100 | 158 | 160 | 150 | 160 |
| March | 100 | 100 | 160 | 165 | 145 | 165 |
| April | 100 | 120 | 165 | 175 | 162½ | 173 |
| May | 120 | 120 | 176 | 180 | 165 | 180 |
| June | 120 | 130 | 180 | 180 | 172½ | 180 |
| July | 120 | 130 | 150 | 180 | 142 | 180 |
| August | 120 | 120 | 132 | 150 | 130 | 142 |
| September | 120 | 130 | 141½ | 159½ | 142½ | 175 |
| October | 130 | 130 | 147½ | 186 | 148½ | 186 |
| November | 130 | 130 | 160 | 184 | 160 | 182 |
| December | 130 | 145 | 153½ | 171 | 154 | 168 |

## SUGAR.

The world's sugar crop in 1900 was 9,516,629 tons of 2,240 pounds, an increase of 1,100,000 tons over the big crop of 1899, and 1,750,000 tons over 1896. The production in the United States of cane sugar, entirely from Louisiana, Hawaii, and Porto Rico, increased from 425,521 tons in 1899 to 661,000 tons in 1900; of beet sugar from 72,994 tons in 1899 to 75,859 tons in 1900. About two-thirds of the beet sugar of this country is produced in nearly equal portions by California and Michigan, while Nebraska, Utah, New York, and Colorado produce over four-fifths of the remainder.

*Sugar crop of the countries named, 1896–1897 to 1900–1901.*

[Tons of 2,240 pounds.]

| Countries. | 1896–1897. | 1897–1898. | 1898–1899. | 1899–1900. | 1900–1901. |
|---|---|---|---|---|---|
| CANE SUGAR. | | | | | |
| United States: | | | | | |
| Louisiana | 282,009 | 310,447 | 245,511 | 132,000 | 270,000 |
| Porto Rico | 58,000 | 54,000 | 53,825 | 35,000 | 85,000 |
| Hawaiian Islands | 224,218 | 204,833 | 252,506 | 258,521 | 306,000 |
| Cuba, crop | 219,500 | 314,009 | 345,261 | 308,543 | 600,000 |
| British West Indies: | | | | | |
| Trinidad, exports | 53,000 | 53,000 | 53,436 | 41,000 | 50,000 |
| Barbadoes, exports | 52,178 | 47,835 | 45,787 | 50,000 | 70,000 |
| Jamaica | 30,000 | 30,000 | 27,000 | 27,000 | 30,000 |
| Antigua and St. Kitts | 29,000 | 25,000 | 22,000 | 18,000 | 25,000 |
| French West Indies: | | | | | |
| Martinique, exports | 35,000 | 31,469 | 31,639 | 30,000 | 35,000 |
| Guadeloupe | 45,000 | 37,136 | 39,390 | 30,000 | 35,000 |
| Danish West Indies: | | | | | |
| St. Croix | 13,058 | 13,000 | 12,000 | 12,000 | 13,000 |
| Haiti and San Domingo | 48,800 | 48,000 | 50,000 | 45,000 | 50,000 |
| Lesser Antilles (not named above) | 8,000 | 8,000 | 8,000 | 8,000 | 8,000 |
| Mexico | ........ | ........ | 50,000 | 78,000 | 93,000 |
| Central America: | | | | | |
| Guatemala | 8,000 | 9,000 | 11,000 | 12,000 | 9,000 |
| San Salvador | 3,000 | 4,000 | 4,500 | 5,000 | 5,000 |
| Nicaragua | 500 | 1,500 | 3,750 | 4,000 | 3,500 |
| Costa Rica | 200 | 500 | 750 | 1,000 | 1,500 |
| South America: | | | | | |
| British Guiana (Demerara), exports | 99,789 | 106,000 | 82,000 | 80,000 | 105,000 |
| Dutch Guiana (Surinam) | 6,000 | 6,000 | 6,000 | 6,000 | 6,000 |
| Venezuela | ........ | ........ | ........ | 2,000 | 3,000 |
| Peru, exports | 71,735 | 101,577 | 61,910 | 100,381 | 105,000 |
| Argentine Republic | 165,000 | 110,000 | 72,000 | 60,000 | 70,000 |
| Brazil | 175,903 | 200,478 | 154,495 | 192,700 | 178,000 |
| Total in America | 1,627,890 | 1,715,784 | 1,632,760 | 1,536,145 | 2,156,000 |
| Asia:[1] | | | | | |
| British India, exports | 28,000 | 20,000 | 10,000 | 10,000 | 15,000 |
| Siam | 7,000 | 7,000 | 7,000 | 7,000 | 7,000 |
| Java, exports | 498,434 | 531,201 | 689,281 | 721,993 | 710,120 |
| Philippine Islands, exports | 202,000 | 178,000 | 93,000 | 62,785 | 30,000 |
| Total in Asia | 735,434 | 736,201 | 799,281 | 801,778 | 762,120 |
| Australia and Polynesia: | | | | | |
| Queensland | 100,774 | 97,916 | 164,241 | 124,871 | 97,650 |
| New South Wales | 31,000 | 26,000 | 28,000 | 15,500 | 19,000 |
| Fiji Islands, exports | 30,000 | 30,000 | 34,000 | 31,000 | 33,000 |
| Total Australia and Polynesia | 161,774 | 153,916 | 226,241 | 171,371 | 149,650 |
| Africa: | | | | | |
| Egypt | 100,000 | 80,178 | 90,822 | 99,000 | 95,000 |
| Mauritius | 152,677 | 121,693 | 186,487 | 157,025 | 190,000 |
| Reunion | 45,082 | 31,483 | 37,781 | 35,000 | 35,000 |
| Total in Africa | 297,759 | 233,354 | 315,090 | 291,025 | 320,000 |
| Europe: | | | | | |
| Spain | 8,000 | 23,000 | 25,000 | 33,215 | 33,000 |
| Total cane-sugar production (Willett & Gray) | 2,830,857 | 2,862,255 | 2,998,372 | 2,833,534 | 3,420,770 |
| BEET SUGAR. | | | | | |
| Europe beet-sugar production (Licht): | | | | | |
| Germany | 1,836,536 | 1,852,857 | 1,721,718 | 1,790,000 | 1,970,000 |
| Austria | 934,007 | 831,667 | 1,051,290 | 1,120,000 | 1,095,000 |
| France | 752,081 | 821,235 | 830,132 | 970,000 | 1,170,000 |
| Russia | 728,667 | 738,715 | 776,066 | 900,000 | 890,000 |
| Belgium | 288,009 | 265,397 | 244,017 | 300,000 | 340,000 |
| Holland | 174,206 | 125,658 | 149,763 | 180,000 | 180,000 |
| Other countries | 202,990 | 196,245 | 209,015 | 275,000 | 375,000 |
| Total in Europe | 4,916,496 | 4,831,774 | 4,982,001 | 5,535,000 | 6,020,000 |

[1] Japan, consumption 170,000 tons, mostly imported. China, consumption large, mostly imported.

*Sugar crop of the countries named, 1896–1897 to 1900–1901*—Continued.

[Tons of 2,240 pounds.]

| Countries. | 1896–1897. | 1897–1898. | 1898–1899. | 1899–1900. | 1900–1901. |
|---|---|---|---|---|---|
| BEET SUGAR—continued. | | | | | |
| United States beet-sugar production (Willett & Gray): | | | | | |
| California | 28,200 | 31,381 | 16,436 | 37,938 | 25,451 |
| Nebraska | 5,246 | 6,579 | 4,721 | 4,591 | 4,406 |
| Utah | 3,640 | 1,641 | 5,764 | 8,574 | 7,630 |
| New Mexico | 450 | 455 | 550 | 446 | ........... |
| New York | ........... | 342 | 1,030 | 1,607 | 3,669 |
| Michigan | ........... | ........... | 2,253 | 14,699 | 23,533 |
| Minnesota | ........... | ........... | 891 | 2,053 | 1,186 |
| Oregon | ........... | ........... | 826 | 982 | 888 |
| Illinois | ........... | ........... | ........... | 804 | 1,150 |
| Colorado | ........... | ........... | ........... | 804 | 5,982 |
| Washington | ........... | ........... | ........... | 446 | 625 |
| Ohio | ........... | ........... | ........... | ........... | 1,339 |
| Total United States | 37,536 | 40,398 | 32,471 | 72,944 | 75,859 |
| Total cane and beet sugar | 7,784,889 | 7,734,427 | 8,012,844 | 8,441,478 | 9,516,629 |

## TOBACCO.

The following table contains statistics of tobacco production in the United States based upon information in possession of the office of the Commissioner of Internal Revenue and of the Bureau of Statistics of the Treasury Department. It is the intention of the Department of Agriculture to resume the annual collection of statistics of production as soon as the Twelfth Census has furnished a new basis for that work in the results of its careful and systematic investigations.

*Production of tobacco in the United States, 1893 to 1898, as compiled from the reports of the Bureau of Internal Revenue and of the Bureau of Statistics of the Treasury Department.*

| | 1893. | 1894. | 1895. | 1896. | 1897. | 1898. | 1899. |
|---|---|---|---|---|---|---|---|
| Tobacco, manufactured: | | | | | | | |
| | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds* | *Pounds.* |
| Chewing, smoking, and snuff [1] | 249,858,869 | 250,994,675 | 234,561,904 | 265,871,158 | 247,358,414 | 258,975,685 | ........... |
| Cigars and cigarettes [1] | 89,973,814 | 93,639,213 | 95,053,056 | 96,213,473 | 102,519,323 | 108,049,132 | ........... |
| Exports, domestic [1] | 304,797,808 | 293,637,217 | 300,047,687 | 281,074,422 | 269,966,833 | 346,823,677 | ........... |
| Exports, foreign [1] | 1,776,636 | 3,060,385 | 2,767,454 | 1,779,103 | 2,323,516 | 1,847,637 | ........... |
| | 646,407,127 | 641,331,490 | 632,430,101 | 644,938,156 | 622,168,086 | 715,696,131 | ........... |
| Less imports [1] | 24,899,175 | 31,355,899 | 20,258,704 | 12,848,743 | 11,307,830 | 17,277,985 | ........... |
| | 621,507,952 | 609,975,591 | 612,171,397 | 632,089,413 | 610,860,256 | 698,418,146 | ........... |

[1] For calendar year following.

UNITED STATES TREASURY DEPARTMENT,
OFFICE OF THE COMMISSIONER OF INTERNAL REVENUE,
*Washington, D. C., March 14, 1900.*

I have made a careful examination and study of the statement of the production of leaf tobacco in the United States for the years 1893 to 1898, inclusive, as compiled by the Division of Statistics, Department of Agriculture, from the reports of this office, and the Bureau of Statistics of this Department, and am of the opinion that the statement is as complete and correct as is possible to be made.

H. C. JONES, *Chief, Tobacco Division.*

## RICE.

No figures on the rice crop of 1900 can be furnished. Full returns will be issued by the United States Census Office. Prices have been higher since the beginning of 1897, with a shade of decline in 1900.

*Wholesale prices of rice per pound, 1896–1900.*

| Date. | New York. | | Cincinnati. | | Memphis. | |
|---|---|---|---|---|---|---|
| | Domestic (good). | | Louisiana. | | Not classed by name. | |
| | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| January | $3\frac{5}{8}$ | $3\frac{5}{8}$ | $2\frac{1}{2}$ | $5\frac{1}{2}$ | 3 | $5\frac{1}{2}$ |
| February | $3\frac{5}{8}$ | $3\frac{5}{8}$ | $2\frac{1}{2}$ | $5\frac{1}{2}$ | 3 | $5\frac{1}{2}$ |
| March | $3\frac{5}{8}$ | $3\frac{5}{8}$ | $2\frac{1}{2}$ | $5\frac{1}{2}$ | 3 | $5\frac{1}{2}$ |
| April | $3\frac{1}{2}$ | $3\frac{5}{8}$ | $2\frac{1}{2}$ | $5\frac{1}{2}$ | $2\frac{1}{4}$ | $4\frac{1}{4}$ |
| May | $3\frac{1}{2}$ | $3\frac{1}{2}$ | $2\frac{1}{4}$ | $5\frac{1}{2}$ | $2\frac{1}{4}$ | $4\frac{1}{4}$ |
| June | $3\frac{3}{4}$ | $3\frac{3}{4}$ | $2\frac{1}{4}$ | $5\frac{1}{4}$ | $2\frac{1}{4}$ | $4\frac{1}{4}$ |
| July | $3\frac{1}{2}$ | $3\frac{3}{4}$ | $2\frac{1}{4}$ | $5\frac{1}{4}$ | $2\frac{1}{4}$ | $5\frac{1}{2}$ |
| August | $3\frac{1}{2}$ | $3\frac{1}{2}$ | $2\frac{1}{4}$ | $5\frac{1}{4}$ | $2\frac{3}{4}$ | $5\frac{3}{4}$ |
| September | $3\frac{1}{2}$ | $3\frac{3}{4}$ | $2\frac{1}{4}$ | 6 | $2\frac{1}{2}$ | $5\frac{1}{2}$ |
| October | $3\frac{3}{4}$ | $3\frac{7}{8}$ | 3 | 6 | $2\frac{1}{2}$ | 6 |
| November | $3\frac{7}{8}$ | $3\frac{7}{8}$ | 3 | $6\frac{1}{2}$ | 4 | $6\frac{1}{2}$ |
| December | $3\frac{7}{8}$ | $4\frac{3}{8}$ | $3\frac{1}{2}$ | $6\frac{1}{2}$ | $3\frac{7}{8}$ | $6\frac{1}{4}$ |
| **1897.** | | | | | | |
| January | $4\frac{3}{8}$ | $4\frac{3}{8}$ | $3\frac{1}{2}$ | $6\frac{1}{2}$ | 4 | 6 |
| February | $4\frac{3}{8}$ | $4\frac{3}{8}$ | $3\frac{1}{2}$ | $6\frac{1}{2}$ | 4 | 6 |
| March | $4\frac{3}{8}$ | $4\frac{1}{2}$ | 4 | $6\frac{1}{2}$ | 4 | 7 |
| April | $4\frac{1}{2}$ | $4\frac{5}{8}$ | 4 | $6\frac{1}{2}$ | 4 | 7 |
| May | $4\frac{3}{8}$ | $4\frac{5}{8}$ | 4 | $6\frac{1}{2}$ | 4 | 7 |
| June | $4\frac{3}{8}$ | $4\frac{3}{8}$ | 4 | $6\frac{1}{2}$ | 4 | 7 |
| July | $4\frac{3}{8}$ | $4\frac{3}{8}$ | 4 | $6\frac{1}{2}$ | $4\frac{1}{2}$ | $6\frac{1}{2}$ |
| August | $4\frac{5}{8}$ | $4\frac{3}{4}$ | 4 | $6\frac{1}{2}$ | 4 | 7 |
| September | $4\frac{3}{4}$ | $4\frac{7}{8}$ | 4 | $6\frac{1}{2}$ | 4 | 7 |
| October | $4\frac{7}{8}$ | $4\frac{7}{8}$ | 4 | $6\frac{1}{2}$ | 4 | 7 |
| November | $4\frac{7}{8}$ | $4\frac{7}{8}$ | 4 | $6\frac{1}{2}$ | 4 | 7 |
| December | $4\frac{7}{8}$ | $4\frac{7}{8}$ | 4 | $6\frac{3}{4}$ | 4 | 7 |
| **1898.** | | | | | | |
| January | $4\frac{7}{8}$ | 5 | $5\frac{3}{4}$ | $6\frac{1}{4}$ | 4 | 7 |
| February | 5 | 5 | $5\frac{3}{4}$ | $6\frac{1}{4}$ | 4 | 7 |
| March | 5 | 5 | $5\frac{3}{4}$ | $6\frac{1}{4}$ | 4 | 7 |
| April | 5 | $5\frac{5}{8}$ | $5\frac{3}{4}$ | $6\frac{1}{2}$ | $3\frac{3}{4}$ | $7\frac{1}{2}$ |
| May | $5\frac{5}{8}$ | $5\frac{5}{8}$ | $6\frac{1}{2}$ | 7 | $4\frac{1}{4}$ | 8 |
| June | $5\frac{5}{8}$ | $5\frac{5}{8}$ | 6 | 7 | $5\frac{1}{4}$ | 8 |
| July | $5\frac{5}{8}$ | $5\frac{5}{8}$ | 6 | $6\frac{1}{2}$ | $5\frac{1}{4}$ | 8 |
| August | $5\frac{1}{4}$ | $5\frac{5}{8}$ | $5\frac{1}{2}$ | $6\frac{1}{2}$ | $4\frac{1}{4}$ | $6\frac{1}{2}$ |
| September | 5 | 5 | $5\frac{1}{2}$ | 6 | $4\frac{1}{4}$ | $6\frac{1}{2}$ |
| October | 5 | $5\frac{1}{4}$ | $5\frac{1}{2}$ | 6 | $4\frac{1}{4}$ | $6\frac{1}{2}$ |
| November | $5\frac{1}{4}$ | $5\frac{1}{2}$ | $5\frac{1}{2}$ | 6 | $4\frac{1}{4}$ | 7 |
| December | $5\frac{1}{4}$ | $5\frac{1}{2}$ | $5\frac{1}{2}$ | 6 | $4\frac{1}{4}$ | 7 |
| **1899.** | | | *Prime.* | | | |
| January | $5\frac{1}{2}$ | $5\frac{1}{2}$ | $5\frac{3}{4}$ | $6\frac{1}{2}$ | $4\frac{1}{2}$ | 7 |
| February | 5 | $5\frac{1}{4}$ | $5\frac{3}{4}$ | $6\frac{1}{2}$ | $4\frac{1}{2}$ | 7 |
| March | $5\frac{1}{4}$ | $5\frac{1}{4}$ | $5\frac{3}{4}$ | $6\frac{3}{4}$ | $4\frac{3}{4}$ | $6\frac{1}{2}$ |
| April | $5\frac{1}{4}$ | $5\frac{1}{4}$ | $5\frac{3}{4}$ | $6\frac{3}{4}$ | $3\frac{3}{4}$ | $6\frac{1}{2}$ |
| May | $5\frac{1}{4}$ | $5\frac{1}{4}$ | $5\frac{1}{2}$ | $6\frac{3}{4}$ | $3\frac{3}{4}$ | $6\frac{1}{2}$ |
| June | $5\frac{1}{4}$ | $5\frac{1}{4}$ | $5\frac{1}{2}$ | $6\frac{1}{4}$ | $4\frac{1}{2}$ | 7 |
| July | $5\frac{1}{4}$ | $5\frac{1}{4}$ | $5\frac{1}{2}$ | 6 | $4\frac{1}{2}$ | 7 |
| August | 5 | $5\frac{1}{4}$ | $5\frac{1}{2}$ | 6 | $4\frac{1}{2}$ | 7 |
| September | 5 | 5 | $5\frac{1}{2}$ | 6 | $4\frac{1}{2}$ | 7 |
| October | 5 | $5\frac{1}{8}$ | $5\frac{1}{2}$ | 6 | $3\frac{1}{2}$ | 7 |
| November | $4\frac{3}{4}$ | 5 | $5\frac{1}{4}$ | 6 | 3 | 7 |
| December | $4\frac{3}{4}$ | $4\frac{3}{4}$ | $5\frac{1}{2}$ | 6 | $2\frac{1}{2}$ | 7 |
| **1900.** | | | *Louisiana.* | | | |
| January | $4\frac{3}{4}$ | $4\frac{3}{4}$ | $5\frac{1}{2}$ | 6 | 3 | 7 |
| February | $4\frac{3}{4}$ | $4\frac{3}{4}$ | $5\frac{1}{2}$ | 6 | 3 | 7 |
| March | $4\frac{3}{4}$ | $4\frac{5}{8}$ | $5\frac{1}{2}$ | 6 | $3\frac{1}{2}$ | 7 |
| April | $4\frac{5}{8}$ | $4\frac{5}{8}$ | $5\frac{1}{2}$ | 6 | $3\frac{3}{4}$ | $6\frac{1}{2}$ |
| May | $4\frac{5}{8}$ | $4\frac{5}{8}$ | $5\frac{1}{2}$ | 6 | 3 | 7 |
| June | $4\frac{3}{4}$ | $4\frac{3}{4}$ | $5\frac{1}{2}$ | 6 | 3 | $7\frac{1}{2}$ |
| July | $4\frac{3}{4}$ | $4\frac{3}{4}$ | $5\frac{1}{2}$ | 6 | 3 | $7\frac{1}{2}$ |
| August | $4\frac{3}{4}$ | $4\frac{3}{4}$ | $5\frac{1}{2}$ | 6 | 3 | $7\frac{1}{2}$ |
| September | $4\frac{3}{4}$ | $4\frac{7}{8}$ | $5\frac{1}{2}$ | 6 | $3\frac{1}{2}$ | $7\frac{1}{2}$ |
| October | $4\frac{3}{4}$ | $4\frac{7}{8}$ | $5\frac{1}{2}$ | 6 | 4 | $7\frac{1}{2}$ |
| November | $4\frac{3}{4}$ | 5 | $5\frac{1}{2}$ | 6 | 4 | 7 |
| December | 5 | 5 | $5\frac{1}{2}$ | 6 | $3\frac{1}{2}$ | $7\frac{1}{2}$ |

## CLOVER SEED.

No figures showing the yield and value of clover seed in the United States have ever been regularly and widely published. Prices were much better for 1900 than at any time in the four years preceding.

*Wholesale prices of clover seed (60 pounds to the bushel), 1896–1900.*

| Date. | New York. Prime (per pound). Low. | High. | Cincinnati. Prime (per 100 pounds). Low. | High. | Chicago. Poor to choice (per 100 lbs.). Low. | High. | Toledo. Poor to choice (per 100 lbs.). Low. | High. |
|---|---|---|---|---|---|---|---|---|
| **1896.** | | | | | | | | |
| January | ........ | ........ | $6.50 | $7.00 | $4.00 | $7.30 | $4.20 | $4.42½ |
| February | $0.07½ | $0.07½ | 6.50 | 7.00 | 4.00 | 7.60 | 4.35 | 4.60 |
| March | .07 | .07½ | 6.50 | 7.00 | 4.00 | 7.50 | 4.35 | 4.50 |
| April | .07 | .07½ | 6.50 | 7.25 | 4.00 | 8.25 | 4.40 | 4.95 |
| May | .07 | .07½ | 6.25 | 7.25 | 4.00 | 7.50 | 4.52½ | 4.85 |
| June | ........ | ........ | 6.25 | 7.00 | 3.50 | 7.50 | 4.40 | 4.55 |
| July | ........ | ........ | | | 3.00 | 7.65 | 4.20 | 4.65 |
| August | ........ | ........ | ........ | ........ | 2.00 | 7.65 | 4.50 | 4.65 |
| | | | *Per bushel.* | | | | | |
| September | .07½ | .08 | 2.75 | 3.60 | 2.50 | 9.00 | 4.35 | 4.50 |
| October | .08 | .09 | 3.00 | 4.25 | 2.00 | 9.00 | 5.00 | 5.95 |
| November | ........ | ........ | 3.00 | 5.00 | 2.00 | 8.35 | 5.45 | 5.55 |
| December | | ........ | 3.00 | 4.50 | 2.00 | 8.50 | 5.45 | 5.45 |
| **1897.** | *Per 100 pounds.* | | | | | | | |
| January | 4.75 | 4.75 | 3.50 | 4.50 | 2.00 | 8.50 | 5.20 | 5.32½ |
| February | 4.75 | 4.75 | 3.75 | 4.50 | 2.00 | 8.50 | 4.60 | 4.90 |
| March | 4.50 | 4.50 | 3.50 | 4.50 | 2.00 | 9.25 | 4.72½ | 5.30 |
| April | 4.50 | 5.00 | 3.50 | 4.50 | 2.50 | 8.50 | 4.30 | 4.95 |
| May | 5.00 | 5.00 | 3.00 | 3.50 | 2.50 | 7.00 | 4.25 | 4.35 |
| June | 5.00 | 5.00 | ........ | ........ | 2.00 | 6.75 | 4.10 | 4.10 |
| July | 5.00 | 5.00 | ........ | ........ | 2.00 | 7.00 | 4.20 | 4.25 |
| August | 5.00 | 5.00 | ........ | ........ | 2.50 | 7.15 | 4.30 | 4.45 |
| September | 3.75 | 4.00 | 3.00 | 3.60 | 2.50 | 7.25 | 3.30 | 4.10 |
| October | 3.25 | 3.87½ | 2.75 | 3.15 | 3.00 | 5.80 | 3.20 | 3.40 |
| November | 3.40 | 3.60 | 2.75 | 3.15 | 2.50 | 5.35 | 3.15 | 3.37½ |
| December | 3.40 | 3.55 | 2.75 | 3.00 | 2.50 | 5.50 | 3.10 | 3.20 |
| **1898.** | | | | | | | | |
| January | 3.40 | 3.55 | 2.75 | 3.00 | 2.50 | 5.40 | 3.12½ | 3.22½ |
| February | 3.45 | 3.45 | 2.75 | 3.00 | 2.50 | 5.40 | 3.05 | 3.20 |
| March | 3.45 | 3.50 | 2.45 | 2.90 | 2.00 | 5.15 | 2.85 | 3.07½ |
| April | 3.50 | 3.50 | 2.45 | 2.65 | 2.50 | 5.00 | 2.85 | 3.15 |
| May | 3.37½ | 3.62½ | 2.45 | 2.65 | 2.50 | 5.50 | 3.00 | 3.30 |
| June | 3.50 | 3.62½ | ........ | ........ | 2.50 | 5.25 | 2.80 | 3.30 |
| July | 3.50 | 3.50 | ........ | ........ | 2.50 | 5.30 | 2.87½ | 3.30 |
| August | 3.50 | 3.50 | ........ | ........ | 2.00 | 5.40 | 3.20 | 3.32½ |
| September | 3.50 | 3.50 | 3.25 | 3.50 | 1.00 | 8.00 | 3.25 | 3.90 |
| October | 3.45 | 4.20 | 3.25 | 3.75 | 3.00 | 8.00 | 3.75 | 5.15 |
| November | 3.97½ | 4.20 | 3.25 | 3.75 | 1.25 | 7.75 | 4.25 | 4.65 |
| December | 3.81 | 3.97½ | 3.25 | 3.75 | 2.50 | 7.25 | 4.00 | 4.65 |
| **1899.** | | | | | | | | |
| January | 6.50 | 6.75 | 3.00 | 3.75 | 3.00 | 7.00 | 4.00 | 4.72½ |
| February | 6.50 | 7.00 | 3.00 | 3.50 | 3.00 | 6.50 | 3.90 | 4.07½ |
| March | 6.25 | 6.75 | 2.85 | 3.40 | 2.50 | 6.10 | 3.42½ | 3.85 |
| April | 5.75 | 6.00 | 2.85 | 3.10 | 2.50 | 6.25 | 3.50 | 3.80 |
| May | 5.50 | 5.87½ | 2.75 | 3.10 | 3.00 | 6.40 | 3.50 | 3.85 |
| June | 5.50 | 5.50 | 2.75 | 3.00 | 3.00 | 6.65 | 3.77½ | 4.05 |
| July | 6.00 | 7.50 | 2.75 | 3.25 | 1.50 | 6.65 | 3.85 | 4.00 |
| August | 6.00 | 7.50 | 3.00 | 3.50 | 2.50 | 6.50 | 3.75 | 4.05 |
| September | 6.50 | 7.50 | 3.50 | 3.75 | 2.50 | 8.40 | 4.60 | 5.85 |
| October | 8.50 | 9.50 | 3.75 | 4.50 | 6.00 | 8.60 | 5.50 | 6.80 |
| November | 7.75 | 8.50 | 3.85 | 4.50 | 5.00 | 8.00 | 5.40 | 6.20 |
| December | 7.75 | 8.75 | 3.85 | 4.50 | 3.00 | 8.50 | 5.40 | 5.72 |
| **1900.** | *Per pound.* | | | | | | | |
| January | .08¼ | .08⅞ | 4.00 | 4.50 | 5.00 | 8.40 | 5.57½ | 5.80 |
| February | .08⅞ | .09 | 4.00 | 4.50 | 5.00 | 8.50 | 5.55 | 5.80 |
| March | .09 | .10 | 4.00 | 4.65 | 4.00 | 8.50 | 5.20 | 5.67½ |
| April | .09¼ | .09¼ | 4.00 | 4.65 | 5.00 | 7.75 | 4.95 | 5.15 |
| May | Nominal. | | 4.00 | 4.20 | 4.00 | 7.50 | 5.00 | 5.00 |
| June | Nominal. | | 4.00 | 4.50 | 4.50 | 8.00 | 5.10 | 5.30 |
| July | Nominal. | | 4.25 | 4.50 | 4.50 | 8.00 | 5.50 | 5.50 |
| August | .10¾ | .10¾ | 4.25 | 5.20 | 4.50 | 8.40 | 5.40 | 6.20 |
| September | .10¼ | .10¾ | 4.80 | 5.75 | 5.00 | 9.75 | 6.10 | 6.10 |
| October | .10¼ | .10½ | 5.00 | 6.00 | 5.00 | 10.50 | 6.50 | 7.85 |
| November | .10 | .10½ | 5.00 | 5.70 | 5.00 | 10.00 | 6.15 | 6.40 |
| December | .10 | .10½ | 5.00 | 5.70 | 4.00 | 10.50 | 6.60 | 6.87½ |

## TIMOTHY SEED.

No figures showing the yield and value of timothy seed in the United States have ever been regularly and widely published. There was a sharp advance in prices in the closing months of 1900.

*Wholesale prices of timothy seed (45 pounds to the bushel), 1896–1900.*

| Date. | New York. | | Cincinnati. | | Chicago. | | Milwaukee. | |
|---|---|---|---|---|---|---|---|---|
| | Per bushel. | | Per 100 lbs. | | Poor to choice, per 100 lbs. | | Per 100 lbs. | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | | | | | | | | |
| January | [1] $1.85\frac{5}{8}$ | | 3.00 | 3.60 | 1.50 | 4.00 | 2.00 | 3.75 |
| February | [1] $1.88\frac{1}{4}$ | | 3.40 | 3.75 | 2.00 | 4.00 | 2.75 | 3.75 |
| March | [1] $1.82\frac{5}{8}$ | | 3.15 | 3.75 | 2.00 | 3.75 | 3.00 | 3.75 |
| April | [1] $1.71\frac{3}{4}$ | | 3.15 | 3.40 | 2.00 | 3.40 | 3.00 | 3.75 |
| May | [1] $1.68\frac{3}{4}$ | | 3.15 | 3.40 | 1.50 | 3.35 | 3.00 | 3.60 |
| June | [1] $1.68\frac{3}{4}$ | | 3.15 | 3.40 | 1.50 | 3.20 | 3.00 | 3.60 |
| | | | *Per bushel.* | | | | | |
| July | [1] $1.68\frac{3}{4}$ | | 1.55 | 1.80 | 1.50 | 3.20 | 3.00 | 3.25 |
| August | [1] $1.66\frac{1}{2}$ | | 1.40 | 1.80 | 1.75 | 2.80 | 2.00 | 3.25 |
| September | [1] $1.67\frac{7}{16}$ | | 1.35 | 1.55 | 1.50 | 2.75 | 1.90 | 2.90 |
| October | [1] $1.49\frac{1}{4}$ | | 1.15 | 1.50 | 1.50 | 2.75 | 1.90 | 2.70 |
| November | [1] $1.48\frac{1}{2}$ | | 1.15 | 1.25 | 1.50 | 2.70 | 2.00 | 2.70 |
| December | [1] $1.48\frac{1}{2}$ | | 1.15 | 1.25 | 1.50 | 2.75 | 2.00 | 2.70 |
| **1897.** | | | | | | | | |
| January | $1.28\frac{1}{4}$ | $1.68\frac{3}{4}$ | 1.15 | 1.25 | 1.50 | 3.00 | 2.00 | 2.70 |
| February | $1.28\frac{1}{4}$ | 1.80 | 1.15 | 1.25 | 1.50 | 3.00 | 2.00 | 2.80 |
| March | $1.28\frac{3}{4}$ | 1.79 | 1.15 | 1.25 | 1.75 | 3.00 | 2.00 | 2.90 |
| April | $1.36\frac{3}{8}$ | $1.82\frac{1}{4}$ | 1.15 | 1.25 | 1.50 | 3.15 | 2.00 | 3.10 |
| May | 1.44 | 1.89 | 1.15 | 1.25 | 2.00 | 3.15 | 2.00 | 3.10 |
| June | 1.44 | 1.89 | ........ | ........ | 1.50 | $2.77\frac{1}{2}$ | 2.00 | 2.90 |
| July | $1.40\frac{1}{2}$ | $1.77\frac{3}{4}$ | ........ | ........ | 1.50 | 2.75 | 2.00 | 2.85 |
| August | 1.35 | $1.68\frac{3}{4}$ | 1.20 | 1.25 | 2.00 | 2.90 | 2.00 | 3.05 |
| September | $1.31\frac{3}{8}$ | $1.64\frac{1}{4}$ | 1.15 | 1.25 | 1.50 | 2.90 | 2.15 | 3.05 |
| October | 1.26 | $1.58\frac{1}{8}$ | 1.15 | 1.25 | 1.50 | 2.75 | 2.15 | 2.80 |
| November | $1.23\frac{3}{4}$ | $1.46\frac{1}{2}$ | 1.15 | 1.25 | 1.75 | 2.70 | 2.15 | 2.80 |
| December | $1.23\frac{3}{4}$ | $1.46\frac{1}{4}$ | 1.15 | 1.25 | 1.75 | 2.80 | 2.15 | 2.80 |
| **1898.** | | | | | | | | |
| January | $1.23\frac{3}{4}$ | $1.46\frac{1}{4}$ | 1.15 | 1.25 | 1.50 | 2.80 | 2.15 | 2.85 |
| February | $1.23\frac{3}{4}$ | $1.46\frac{1}{4}$ | 1.15 | 1.25 | 1.50 | 3.00 | 2.25 | 3.00 |
| March | $1.23\frac{3}{4}$ | $1.46\frac{1}{4}$ | 1.15 | 1.25 | 1.25 | 3.00 | 2.35 | 3.00 |
| April | $1.26\frac{1}{2}$ | $1.59\frac{3}{16}$ | 1.15 | 1.25 | 1.50 | 3.00 | 2.35 | 3.00 |
| May | 1.35 | $1.68\frac{3}{4}$ | 1.15 | 1.25 | 1.50 | 2.90 | 2.20 | 3.00 |
| June | 1.35 | $1.68\frac{3}{4}$ | ........ | ........ | 1.50 | 2.90 | 2.00 | 2.90 |
| July | $1.30\frac{3}{4}$ | $1.63\frac{11}{16}$ | ........ | ........ | 1.00 | 2.70 | 2.00 | 2.60 |
| August | $1.30\frac{1}{4}$ | $1.57\frac{1}{16}$ | 1.08 | 1.17 | 1.00 | 2.60 | 1.75 | 2.70 |
| September | $1.16\frac{9}{16}$ | $1.53\frac{7}{16}$ | .95 | 1.17 | 1.00 | 2.55 | 1.50 | 2.50 |
| October | $1.12\frac{1}{2}$ | $1.41\frac{7}{8}$ | .95 | 1.10 | 1.00 | 2.40 | 1.60 | 2.50 |
| November | $1.12\frac{1}{2}$ | 1.35 | .95 | 1.00 | .75 | 2.35 | 1.70 | 2.50 |
| December | $1.13\frac{3}{8}$ | 1.35 | .95 | 1.00 | 1.00 | 2.30 | 1.70 | 2.50 |
| **1899.** | | | | | | | | |
| January | $1.14\frac{5}{16}$ | $1.26\frac{9}{16}$ | .95 | 1.05 | 1.25 | $2.42\frac{1}{2}$ | 1.70 | 2.50 |
| February | $1.13\frac{15}{16}$ | 1.35 | 1.00 | 1.05 | 1.50 | $2.47\frac{1}{2}$ | 1.85 | 2.50 |
| March | $1.19\frac{9}{16}$ | 1.35 | 1.00 | 1.05 | 1.75 | $2.47\frac{1}{2}$ | 1.75 | 2.50 |
| April | $1.12\frac{1}{2}$ | 1.30 | 1.00 | 1.05 | 1.50 | $2.47\frac{1}{2}$ | 1.75 | 2.75 |
| May | $1.12\frac{1}{2}$ | $1.44\frac{7}{8}$ | 1.00 | 1.05 | 1.50 | 2.40 | 1.90 | 2.65 |
| June | $1.12\frac{1}{2}$ | $1.46\frac{1}{4}$ | ........ | ........ | 1.50 | 2.40 | 1.90 | 2.65 |
| July | $1.18\frac{13}{16}$ | $1.38\frac{5}{8}$ | ........ | ........ | 1.25 | 2.75 | 1.90 | 2.80 |
| August | $1.24\frac{3}{16}$ | $1.46\frac{1}{4}$ | 1.10 | 1.15 | 1.50 | 2.55 | 1.75 | 2.80 |
| September | $1.23\frac{3}{4}$ | $1.52\frac{5}{8}$ | 1.10 | 1.15 | 1.75 | 2.50 | 1.80 | 2.60 |
| October | $1.23\frac{3}{4}$ | $1.57\frac{1}{2}$ | 1.03 | 1.15 | 1.75 | $2.42\frac{1}{2}$ | 1.80 | 2.45 |
| November | ........ | ........ | 1.03 | 1.07 | 1.00 | 2.50 | 1.90 | 2.45 |
| December | 1.17 | $1.46\frac{1}{4}$ | 1.03 | 1.07 | 1.50 | 2.45 | 1.85 | 2.50 |
| **1900.** | *Per 100 pounds.* | | | | | | | |
| January | 2.60 | 3.25 | 1.03 | 1.07 | 1.75 | 2.60 | 2.00 | 2.50 |
| February | 2.50 | 3.50 | 1.03 | 1.12 | 1.75 | 2.65 | 2.00 | 2.50 |
| March | 2.50 | 3.50 | 1.05 | 1.12 | 1.50 | 2.75 | 1.90 | 2.55 |
| April | 2.75 | 3.50 | 1.07 | 1.12 | 1.50 | 2.60 | 1.90 | 2.55 |
| May | 2.75 | 3.50 | 1.07 | 1.12 | 1.50 | 2.60 | 1.90 | 2.60 |
| June | 2.75 | 3.50 | 1.07 | 1.12 | 1.50 | 3.40 | 2.00 | 3.15 |
| July | Nominal. | | 1.15 | 1.40 | 2.25 | 3.40 | 2.65 | 3.25 |
| August | Nominal. | | 1.35 | 1.80 | 2.75 | 3.85 | 2.75 | 4.25 |
| September | 4.20 | 5.55 | 1.60 | 2.00 | 3.00 | 4.65 | 3.50 | 4.50 |
| October | 4.20 | 5.55 | 1.70 | 2.00 | 3.25 | 4.65 | 3.50 | 4.30 |
| November | 4.20 | 5.50 | 1.70 | 1.85 | 3.00 | 4.30 | 3.50 | 4.02 |
| December | 4.50 | 5.00 | 1.70 | 1.85 | 3.50 | 4.65 | 3.50 | 4.40 |

[1] Average.

## FARM ANIMALS AND THEIR PRODUCTS.

The tables showing the numbers and values of farm animals which have appeared regularly in the Yearbooks of this Department for several years are omitted from this book. The reason is furnished in the following announcement by the Statistician of the Department:

"Pending the forthcoming publication of the Census report on live stock, which will be used for the verification or correction of the Department's figures for the year 1900, the Statistician has temporarily discontinued his own estimates of the number and value of farm animals. While this omission renders it impossible to make any definite statement as to the losses from disease and exposure during the year ending March 31, 1901 (the losses being reported as a percentage of the total number of farm animals), the reports received from correspondents leave absolutely no room for doubt that owing mainly to the general mildness of the past winter such losses have been much below the average of a series of years."

### HORSES.

In the prices of horses there appears from the figures collected a gradual advance for the past five years. All grades except Western show a steady market for 1900.

*Range of prices for horses in Omaha, monthly, 1896–1900.*

| Date. | Drafts. | | General purpose. | | Southern. | | Western. | | Drivers. | | Carriage teams. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | | | | | | | | | | | | |
| January | $75.00 | $90.00 | $30.00 | $50.00 | $15.00 | $30.00 | $15.00 | $22.50 | $50.00 | $85.00 | $100.00 | $200.00 |
| February | 80.00 | 100.00 | 30.00 | 55.00 | 15.00 | 35.00 | 15.00 | 20.00 | 50.00 | 90.00 | 100.00 | 225.00 |
| March | 82.50 | 105.00 | 32.50 | 60.00 | 15.00 | 40.00 | 15.00 | 22.50 | 60.00 | 100.00 | 110.00 | 240.00 |
| April | 85.00 | 110.00 | 35.00 | 60.00 | 17.50 | 40.00 | 15.00 | 25.00 | 65.00 | 125.00 | 125.00 | 275.00 |
| May | 85.00 | 110.00 | 35.00 | 60.00 | 17.50 | 40.00 | 15.00 | 25.00 | 65.00 | 125.00 | 125.00 | 275.00 |
| June | 82.50 | 105.00 | 30.00 | 50.00 | 15.00 | 37.50 | 12.50 | 22.50 | 60.00 | 120.00 | 115.00 | 240.00 |
| July | 80.00 | 100.00 | 25.00 | 45.00 | 15.00 | 32.50 | 12.50 | 22.50 | 55.00 | 125.00 | 105.00 | 220.00 |
| August | 75.00 | 90.00 | 22.50 | 40.00 | 15.00 | 30.00 | 12.50 | 20.00 | 50.00 | 120.00 | 100.00 | 210.00 |
| September | 75.00 | 90.00 | 20.00 | 35.00 | 15.00 | 30.00 | 12.50 | 20.00 | 50.00 | 110.00 | 100.00 | 175.00 |
| October | 80.00 | 100.00 | 22.50 | 40.00 | 15.00 | 27.50 | 12.50 | 27.50 | 50.00 | 115.00 | 100.00 | 200.00 |
| November | 65.00 | 90.00 | 20.00 | 35.00 | 15.00 | 25.00 | 10.00 | 20.00 | 40.00 | 100.00 | 100.00 | 200.00 |
| December | 85.00 | 100.00 | 35.00 | 60.00 | 15.00 | 35.00 | 15.00 | 25.00 | 50.00 | 100.00 | 125.00 | 250.00 |
| **1897.** | | | | | | | | | | | | |
| January | 65.00 | 90.00 | 30.00 | 55.00 | 20.00 | 40.00 | 13.00 | 20.00 | 40.00 | 90.00 | 110.00 | 225.00 |
| February | 75.00 | 100.00 | 35.00 | 60.00 | 20.00 | 45.00 | 15.00 | 20.00 | 45.00 | 100.00 | 110.00 | 225.00 |
| March | 85.00 | 110.00 | 40.00 | 60.00 | 20.00 | 40.00 | 12.00 | 20.00 | 50.00 | 110.00 | 125.00 | 250.00 |
| April | 90.00 | 115.00 | 40.00 | 60.00 | 15.00 | 35.00 | 12.00 | 20.00 | 60.00 | 125.00 | 150.00 | 300.00 |
| May | 85.00 | 110.00 | 40.00 | 60.00 | 15.00 | 30.00 | 14.00 | 25.00 | 60.00 | 125.00 | 150.00 | 300.00 |
| June | 85.00 | 110.00 | 35.00 | 55.00 | 15.00 | 30.00 | 15.00 | 25.00 | 50.00 | 120.00 | 150.00 | 300.00 |
| July | 90.00 | 115.00 | 30.00 | 50.00 | 15.00 | 30.00 | 15.00 | 25.00 | 45.00 | 110.00 | 125.00 | 250.00 |
| August | 100.00 | 125.00 | 30.00 | 50.00 | 15.00 | 30.00 | 15.00 | 30.00 | 40.00 | 100.00 | 125.00 | 250.00 |
| September | 100.00 | 125.00 | 35.00 | 55.00 | 10.00 | 30.00 | 15.00 | 30.00 | 40.00 | 100.00 | 150.00 | 300.00 |
| October | 90.00 | 115.00 | 35.00 | 55.00 | 10.00 | 30.00 | 15.00 | 30.00 | 35.00 | 85.00 | 150.00 | 300.00 |
| November | 85.00 | 110.00 | 35.00 | 60.00 | 15.00 | 35.00 | 15.00 | 25.00 | 35.00 | 85.00 | 150.00 | 300.00 |
| December | 60.00 | 85.00 | 30.00 | 50.00 | 20.00 | 40.00 | 12.00 | 20.00 | 35.00 | 80.00 | 100.00 | 200.00 |
| **1898.** | | | | | | | | | | | | |
| January | 75.00 | 100.00 | 30.00 | 55.00 | 20.00 | 45.00 | 13.00 | 20.00 | 40.00 | 90.00 | 150.00 | 300.00 |
| February | 75.00 | 100.00 | 35.00 | 60.00 | 20.00 | 45.00 | 15.00 | 20.00 | 45.00 | 100.00 | 150.00 | 300.00 |
| March | 85.00 | 110.00 | 40.00 | 60.00 | 20.00 | 40.00 | 12.00 | 20.00 | 50.00 | 110.00 | 150.00 | 300.00 |
| April | 90.00 | 115.00 | 40.00 | 60.00 | 20.00 | 40.00 | 12.00 | 20.00 | 60.00 | 125.00 | 150.00 | 350.00 |
| May | 85.00 | 110.00 | 40.00 | 60.00 | 20.00 | 40.00 | 14.00 | 25.00 | 60.00 | 150.00 | 150.00 | 400.00 |
| June | 85.00 | 110.00 | 35.00 | 55.00 | 15.00 | 35.00 | 15.00 | 30.00 | 50.00 | 125.00 | 150.00 | 350.00 |
| July | 90.00 | 115.00 | 30.00 | 50.00 | 15.00 | 35.00 | 15.00 | 35.00 | 50.00 | 125.00 | 125.00 | 300.00 |
| August | 100.00 | 125.00 | 30.00 | 50.00 | 15.00 | 35.00 | 15.00 | 40.00 | 40.00 | 125.00 | 125.00 | 300.00 |
| September | 100.00 | 125.00 | 35.00 | 55.00 | 10.00 | 35.00 | 15.00 | 45.00 | 40.00 | 125.00 | 150.00 | 300.00 |
| October | 90.00 | 125.00 | 35.00 | 55.00 | 10.00 | 35.00 | 15.00 | 45.00 | 35.00 | 100.00 | 150.00 | 300.00 |
| November | 100.00 | 125.00 | 35.00 | 60.00 | 15.00 | 35.00 | 15.00 | 40.00 | 35.00 | 100.00 | 150.00 | 300.00 |
| December | 70.00 | 90.00 | 35.00 | 50.00 | 20.00 | 40.00 | 12.00 | 20.00 | 35.00 | 100.00 | 150.00 | 300.00 |
| **1899.** | | | | | | | | | | | | |
| January | 75.00 | 115.00 | 35.00 | 60.00 | 20.00 | 45.00 | 10.00 | 20.00 | 95.00 | 225.00 | 200.00 | 300.00 |
| February | 80.00 | 120.00 | 35.00 | 65.00 | 20.00 | 50.00 | 10.00 | 20.00 | 95.00 | 225.00 | 200.00 | 300.00 |
| March | 90.00 | 125.00 | 40.00 | 65.00 | 20.00 | 50.00 | 10.00 | 20.00 | 95.00 | 225.00 | 200.00 | 300.00 |
| April | 90.00 | 140.00 | 40.00 | 70.00 | 20.00 | 50.00 | 10.00 | 20.00 | 95.00 | 225.00 | 200.00 | 300.00 |
| May | 100.00 | 150.00 | 40.00 | 70.00 | 20.00 | 45.00 | 12.50 | 22.50 | 90.00 | 325.00 | 300.00 | 450.00 |
| June | 90.00 | 140.00 | 40.00 | 65.00 | 15.00 | 45.00 | 12.50 | 25.00 | 90.00 | 325.00 | 300.00 | 450.00 |

*Range of prices for horses in Omaha, monthly, 1896–1900*—Continued.

| Date. | Drafts. | | General purpose. | | Southern. | | Western. | | Drivers. | | Carriage teams. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| 1899. | | | | | | | | | | | | |
| July | $90.00 | $140.00 | $40.00 | $60.00 | $15.00 | $45.00 | $15.00 | $27.50 | $75.00 | $200.00 | $200.00 | $325.00 |
| August | 90.00 | 140.00 | 40.00 | 60.00 | 15.00 | 45.00 | 17.50 | 30.00 | 75.00 | 220.00 | 210.00 | 420.00 |
| September | 90.00 | 140.00 | 40.00 | 60.00 | 15.00 | 45.00 | 20.00 | 40.00 | 85.00 | 175.00 | 215.00 | 360.00 |
| October | 100.00 | 160.00 | 40.00 | 65.00 | 20.00 | 45.00 | 30.00 | 77.50 | 90.00 | 215.00 | 175.00 | 435.00 |
| November | 90.00 | 150.00 | 40.00 | 60.00 | 20.00 | 50.00 | 30.00 | 65.00 | 90.00 | 325.00 | 230.00 | 370.00 |
| December | 100.00 | 160.00 | 35.00 | 60.00 | 20.00 | 55.00 | 29.00 | 45.00 | 90.00 | 300.00 | 200.00 | 375.00 |
| 1900. | | | | | | | | | | | | |
| January | 75.00 | 135.00 | 55.00 | 85.00 | 20.00 | 45.00 | 10.00 | 20.00 | 95.00 | 225.00 | 200.00 | 300.00 |
| February | 80.00 | 150.00 | 55.00 | 90.00 | 20.00 | 50.00 | 10.00 | 20.00 | 95.00 | 225.00 | 200.00 | 300.00 |
| March | 90.00 | 165.00 | 55.00 | 90.00 | 20.00 | 50.00 | 10.00 | 20.00 | 95.00 | 225.00 | 200.00 | 300.00 |
| April | 90.00 | 175.00 | 60.00 | 100.00 | 20.00 | 50.00 | 10.00 | 20.00 | 95.00 | 225.00 | 200.00 | 300.00 |
| May | 100.00 | 150.00 | 65.00 | 105.00 | 20.00 | 45.00 | 12.50 | 22.50 | 90.00 | 325.00 | 300.00 | 450.00 |
| June | 90.00 | 140.00 | 40.00 | 65.00 | 15.00 | 45.00 | 12.50 | 25.00 | 90.00 | 325.00 | 300.00 | 450.00 |
| July | 90.00 | 140.00 | 40.00 | 60.00 | 15.00 | 45.00 | 15.00 | 27.50 | 75.00 | 200.00 | 200.00 | 325.00 |
| August | 90.00 | 140.00 | 40.00 | 60.00 | 15.00 | 45.00 | 17.50 | 30.00 | 75.00 | 220.00 | 210.00 | 420.00 |
| September | 90.00 | 140.00 | 40.00 | 60.00 | 15.00 | 45.00 | 20.00 | 40.00 | 85.00 | 175.00 | 215.00 | 360.00 |
| October | 100.00 | 160.00 | 40.00 | 65.00 | 20.00 | 45.00 | 30.00 | 77.50 | 90.00 | 215.00 | 175.00 | 435.00 |
| November | 90.00 | 150.00 | 40.00 | 60.00 | 20.00 | 50.00 | 12.50 | 45.00 | 90.00 | 325.00 | 230.00 | 370.00 |
| December | 100.00 | 160.00 | 35.00 | 60.00 | 20.00 | 55.00 | 12.50 | 40.00 | 90.00 | 300.00 | 200.00 | 375.00 |

## CATTLE AND DAIRY PRODUCTS.

Prices of cattle are reported as well maintained since 1897, when a good advance was recorded. The market in 1900, as is usually the case, appears to have been strongest on the high grades. Prices of butter improved notably in 1898 and have been quite steadily maintained since that time. Prices of cheese advanced in 1899 and have since held their own with the usual decline in the summer.

*Wholesale prices of cattle per 100 pounds, 1896–1900.*

| Date. | Chicago. | | Cincinnati. | | St. Louis. | | Omaha. | |
|---|---|---|---|---|---|---|---|---|
| | Inferior to prime. | | Fair to medium. | | Good to choice native steers. | | Native beeves. | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| 1896. | | | | | | | | |
| January | $1.75 | $5.05 | $3.25 | $3.75 | $3.00 | $4.45 | $3.00 | $4.30 |
| February | 2.00 | 4.85 | 3.15 | 3.85 | 3.00 | 4.50 | 3.00 | 4.15 |
| March | 2.00 | 4.80 | 3.00 | 3.75 | 3.00 | 4.50 | 3.00 | 4.10 |
| April | 2.00 | 4.70 | 3.00 | 3.75 | 3.25 | 4.20 | 3.00 | 4.15 |
| May | 2.00 | 4.45 | 3.15 | 3.80 | 3.25 | 4.25 | 3.00 | 4.15 |
| June | 2.00 | 4.55 | 3.00 | 3.65 | 3.25 | 4.30 | 3.00 | 4.30 |
| July | 1.75 | 4.65 | 3.10 | 3.75 | 3.25 | 4.45 | 3.00 | 4.25 |
| August | 1.75 | 4.90 | 3.00 | 3.75 | 3.25 | 4.50 | 3.25 | 4.35 |
| September | 1.75 | 5.10 | 3.00 | 3.65 | 3.25 | 4.90 | 3.40 | 4.70 |
| October | 1.75 | 5.30 | 3.00 | 3.50 | 3.25 | 4.65 | 3.25 | 4.75 |
| November | 1.75 | 5.40 | 3.00 | 3.75 | 3.25 | 5.00 | 3.25 | 4.65 |
| December | 1.75 | 6.00 | 3.00 | 3.75 | 3.25 | 5.10 | 3.25 | 4.50 |
| 1897. | | | | | | | | |
| January | 1.75 | 5.40 | 3.35 | 3.90 | 3.25 | 4.50 | 3.00 | 4.75 |
| February | 1.75 | 5.50 | 3.25 | 3.85 | 3.25 | 4.50 | 3.35 | 4.85 |
| March | 2.25 | 5.65 | 3.10 | 3.85 | 3.25 | 4.60 | 3.15 | 5.00 |
| April | 2.40 | 5.60 | 3.15 | 3.90 | 3.50 | 5.00 | 3.50 | 5.00 |
| May | 2.40 | 5.50 | 3.35 | 4.00 | 4.00 | 5.00 | 3.35 | 4.80 |
| June | 2.25 | 5.45 | 3.35 | 4.00 | 4.00 | 5.00 | 3.00 | 4.90 |
| July | 2.25 | 5.35 | 3.25 | 3.90 | 3.75 | 5.00 | 3.35 | 4.70 |
| August | 2.00 | 5.50 | 3.00 | 3.90 | 3.75 | 4.90 | 3.50 | 5.05 |
| September | 2.25 | 5.75 | 3.10 | 3.90 | 4.00 | 5.10 | 3.25 | 5.20 |
| October | 2.25 | 5.65 | 3.00 | 3.90 | 4.00 | 5.25 | 3.00 | 5.05 |
| November | 2.25 | 5.45 | 3.15 | 3.90 | 4.00 | 5.25 | 3.50 | 4.95 |
| December | 2.25 | 5.60 | 3.10 | 3.85 | 4.00 | 5.00 | 3.00 | 5.00 |
| 1898. | | | | | | | | |
| January | 2.25 | 5.60 | 3.25 | 4.00 | 4.25 | 5.15 | 3.50 | 4.75 |
| February | 2.40 | 5.65 | 3.40 | 4.00 | 4.10 | 5.15 | 3.50 | 4.90 |
| March | 2.60 | 5.85 | 3.40 | 4.00 | 4.25 | 5.30 | 3.50 | 5.20 |

*Wholesale prices of cattle per 100 pounds, 1896–1900*—Continued.

| Date. | Chicago. | | Cincinnati. | | St. Louis. | | Omaha. | |
|---|---|---|---|---|---|---|---|---|
| | Inferior to prime. | | Fair to medium. | | Good to choice native steers. | | Native beeves. | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| 1898. | | | | | | | | |
| April | $2.50 | $5.75 | $3.40 | $4.25 | $4.10 | $5.40 | $3.50 | $5.00 |
| May | 2.70 | 5.35 | 3.25 | 4.15 | 4.00 | 5.10 | 3.50 | 4.85 |
| June | 2.70 | 5.40 | 3.10 | 4.00 | 4.35 | 5.15 | 3.40 | 5.50 |
| July | 2.70 | 5.55 | 3.25 | 4.15 | 4.35 | 5.50 | 3.50 | 5.40 |
| August | 2.70 | 5.75 | 3.25 | 4.25 | 4.00 | 5.65 | 3.75 | 5.50 |
| September | 2.70 | 5.85 | 3.25 | 4.25 | 4.25 | 5.65 | 3.50 | 5.40 |
| October | 2.60 | 5.90 | 3.25 | 4.15 | 4.50 | 5.50 | 3.25 | 5.35 |
| November | 2.50 | 5.75 | 3.15 | 4.10 | 4.00 | 5.30 | 3.25 | 5.25 |
| December | 2.50 | 6.25 | 3.25 | 4.00 | 4.00 | 5.40 | 3.00 | 5.80 |
| 1899. | | | | | *1,000 to 1,200 lbs.* | | | |
| January | 2.00 | 6.30 | 3.25 | 4.00 | 4.25 | 5.80 | 3.75 | 5.50 |
| February | 2.50 | 6.30 | 3.40 | 4.00 | 4.10 | 5.75 | 3.75 | 5.50 |
| March | 2.70 | 5.90 | 3.40 | 4.35 | 4.00 | 5.00 | 3.85 | 5.40 |
| April | 2.70 | 5.90 | 3.35 | 4.25 | 4.10 | 5.25 | 4.00 | 5.50 |
| May | 2.70 | 5.65 | 3.50 | 4.50 | 4.00 | 5.10 | 4.25 | 5.50 |
| June | 2.80 | 5.70 | 3.50 | 4.50 | 4.00 | 5.40 | 4.00 | 5.50 |
| July | 2.80 | 6.00 | 3.50 | 4.15 | 4.10 | 5.50 | 4.00 | 5.80 |
| August | 2.80 | 6.65 | 3.75 | 4.35 | 4.00 | 5.85 | 4.00 | 6.25 |
| September | 2.80 | 6.90 | 3.25 | 4.15 | 4.10 | 5.90 | 4.00 | 6.15 |
| October | 2.80 | 7.01 | 3.00 | 4.35 | 4.00 | 5.80 | 4.25 | 6.30 |
| November | 2.80 | 6.90 | 3.35 | 4.25 | 4.00 | 5.70 | 4.50 | 6.05 |
| December | 2.80 | 7.00 | 3.40 | 4.40 | 4.00 | 6.00 | 4.00 | 7.25 |
| 1900. | | | | | *1,000 to 1,400 lbs.* | | | |
| January | 2.25 | 6.60 | 3.25 | 4.25 | 4.20 | 6.00 | 4.00 | 6.25 |
| February | 2.25 | 6.10 | 3.35 | 4.35 | 4.20 | 5.75 | 3.75 | 5.55 |
| March | 2.25 | 6.05 | 3.40 | 4.50 | 4.55 | 5.50 | 3.75 | 5.20 |
| April | 2.25 | 6.00 | 3.75 | 4.65 | 4.50 | 5.75 | 3.75 | 5.25 |
| May | 2.50 | 5.80 | 4.10 | 4.70 | 4.50 | 5.50 | 4.00 | 5.30 |
| June | 2.25 | 5.90 | 4.00 | 4.60 | 4.40 | 5.60 | 4.00 | 5.40 |
| July | 2.25 | 5.75 | 3.75 | 4.50 | 4.25 | 5.70 | 4.00 | 5.50 |
| August | 2.25 | 6.10 | 3.65 | 4.60 | 4.25 | 6.00 | 4.00 | 5.80 |
| September | 2.25 | 6.00 | 3.75 | 4.60 | 4.20 | 5.85 | 3.75 | 5.70 |
| October | 1.75 | 6.00 | 3.10 | 4.40 | 4.10 | 5.85 | 3.75 | 5.50 |
| November | 1.75 | 6.00 | 3.00 | 4.15 | 4.00 | 5.85 | 3.75 | 5.50 |
| December | 1.75 | ........ | 3.00 | 4.25 | 4.10 | 6.50 | 3.50 | 7.50 |

*Wholesale prices of butter per pound in leading cities of the United States, 1896–1900.*

| Date. | New York. | | Cincinnati. | | Chicago. | | Elgin. | |
|---|---|---|---|---|---|---|---|---|
| | Creamery extra. | | Creamery. | | Creamery firsts. | | Creamery extra. | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| 1896. | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| January | 20 | 25 | 15 | 18 | 17 | 24 | 19½ | 23½ |
| February | 18 | 22 | 15 | 16 | 16½ | 21½ | 18 | 21 |
| March | 21 | 22 | 15 | 17 | 19 | 21½ | 20 | 22 |
| April | 14 | 21 | 12 | 15 | 13 | 21 | 14 | 18 |
| May | 15 | 16 | 12 | 13 | 13 | 15½ | 15 | 16 |
| June | 15½ | 15½ | 12 | 13 | 13 | 15 | 14 | 15½ |
| July | 15 | 15½ | 12 | 14 | 12½ | 14½ | 14 | 15 |
| August | 15 | 16½ | 12 | 15 | 12 | 16½ | 14½ | 17 |
| September | 15 | 16½ | 12 | 15 | 12 | 16 | 15 | 16 |
| October | 16 | 20 | 13 | 16 | 13 | 19 | 16½ | 20 |
| November | 20 | 23 | 15 | 20 | 16 | 22 | 18 | 23¼ |
| December | 21 | 24 | 16 | 20 | 18 | 23 | 20 | 24½ |
| 1897. | | | | | | | | |
| January | 20 | 22 | 15 | 16 | 17 | 21 | 19 | 20⅛ |
| February | 19 | 21½ | 15 | 17 | 16 | 20½ | 18 | 21 |
| March | 19 | 20 | 15 | 20 | 16 | 19 | 18 | 22⅛ |
| April | 17 | 22 | 13 | 20 | 14 | 21 | 16 | 20 |
| May | 14 | 17 | 12 | 14 | 12½ | 16 | 13⅝ | 15 |
| June | 15 | 15 | 12 | 13 | 13 | 15 | 14 | 14⅝ |
| July | 15 | 15 | 12 | 13 | 12½ | 14½ | 14½ | 14⅝ |
| August | 15 | 18½ | 12 | 18 | 12½ | 18½ | 14¼ | 18 |
| September | 18 | 21 | 15 | 18 | 15½ | 20½ | 17 | 22 |
| October | 21 | 23½ | 16 | 22 | 19 | 23 | 22 | 23 |
| November | 23 | 23½ | 14 | 18 | 19 | 23 | 22 | 23 |
| December | 22 | 24 | 18 | 20 | 18 | 23 | 21 | 22½ |

*Wholesale prices of butter per pound in leading cities of the United States, 1896–1900*—Continued.

| Date. | New York. | | Cincinnati. | | Chicago. | | Elgin. | |
|---|---|---|---|---|---|---|---|---|
| | Creamery extra. | | Creamery. | | Creamery firsts. | | Creamery extra. | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| 1898. | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| January | 20 | 22 | 16 | 20 | 16 | 21 | 19 | 21 |
| February | 20 | 20½ | 16 | 18 | 16 | 19½ | 19 | 20 |
| March | 19 | 20½ | 16 | 18 | 16 | 20 | 18½ | 19½ |
| April | 17 | 22 | 14 | 18 | 15 | 21 | 16½ | 20 |
| May | 15 | 17 | 14 | 16 | 14 | 16½ | 15 | 16½ |
| June | 16 | 17 | 13 | 15 | 14½ | 16 | 15½ | 16 |
| July | 16½ | 18½ | 14 | 15 | 14½ | 17½ | 16 | 17½ |
| August | 18½ | 19 | 16 | 17 | 16 | 18½ | 18 | 18½ |
| September | 18½ | 31 | 16 | 18 | 15½ | 20 | 18 | 20 |
| October | 20½ | 23 | 16 | 18 | 17 | 22 | 20 | 22 |
| November | 23 | 23½ | 18 | 19 | 19 | 22 | 22 | 22 |
| December | 20 | 23½ | 17 | 18 | 16 | 22 | 20½ | 22 |
| 1899. | | | | | | | | |
| January | 19 | 21 | 16 | 18 | 14 | 20½ | 18 | 20½ |
| February | 19 | 25 | 17 | 20 | 14 | 21½ | 20 | 22 |
| March | 20 | 22 | 19 | 20 | 17 | 21 | 20 | 20½ |
| April | 17 | 21½ | 18 | 19 | 14 | 21 | 17 | 20½ |
| May | 16½ | 19 | 16 | 17 | 14 | 18½ | 16 | 18 |
| June | 18 | 18½ | 17 | 18 | 16 | 18 | 18 | 18 |
| July | 17½ | 18½ | 16½ | 18 | 15½ | 18 | 17½ | 18 |
| August | 17½ | 21 | 16½ | 20 | 15½ | 20 | 18 | 20 |
| September | 20½ | 23 | 18 | 20 | 17½ | 22½ | 21 | 22½ |
| October | 23½ | 24 | 18 | 20 | 18 | 23 | 23½ | 23½ |
| November | 24 | 27 | 18 | 24 | 19 | 26 | 24½ | 26½ |
| December | 26½ | 28 | 21 | 24 | 21 | 27 | 26 | 27 |
| 1900. | | | | | | | | |
| January | 24 | 30 | 21 | 27 | 22 | 29 | 24 | 29 |
| February | 24 | 26 | 21 | 22 | 21 | 24½ | 24 | 24 |
| March | 23½ | 26 | 21 | 22 | 20 | 24½ | 24 | 24½ |
| April | 17½ | 23 | 16 | 20 | 15½ | 22 | 18 | 22½ |
| May | 18½ | 19½ | 16 | 18 | 16 | 19½ | 19½ | 19½ |
| June | ........ | ........ | 16 | 18 | 16½ | 19½ | 18 | 19½ |
| July | 19 | 20 | 17 | 18 | 17 | 19 | 19 | 19 |
| August | 18½ | 21 | 17 | 20 | 17 | 21 | 19½ | 21½ |
| September | 21 | 22 | 19 | 21 | 17½ | 21½ | 20½ | 21½ |
| October | 20½ | 22½ | 18 | 21 | 17 | 22 | 20½ | 22 |
| November | 22½ | 27 | 20 | 25 | 18 | 25½ | 22 | 26 |
| December | 25 | 26 | 23 | 24 | 20 | 24 | 24½ | 25 |

*Wholesale prices of cheese per pound in leading cities of the United States, 1896–1900.*

| Date. | New York. | | Cincinnati. | | Chicago. | | St. Louis. | |
|---|---|---|---|---|---|---|---|---|
| | September, colored. | | Factory. | | Full cream. | | Full cream. | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| 1896. | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| January | 10 | 10¼ | 9½ | 10 | 7½ | 9¾ | 9 | 10½ |
| February | 10¼ | 10¼ | 9½ | 10 | 8 | 10½ | 9 | 10½ |
| March | 10¼ | 10¼ | 9½ | 10 | 8 | 10½ | 8¾ | 10½ |
| April | 9¾ | 10¼ | 9½ | 10 | 8 | 10½ | 9 | 10 |
| May | 9½ | 9¾ | 7 | 10 | 7¼ | 10½ | 8¼ | 10 |
| June | 6⅝ | 7¼ | 7 | 8 | 6¾ | 7¼ | 8 | 8½ |
| July | 6¾ | 6⅞ | 7 | 8 | 6 | 7¼ | 7¾ | 8¼ |
| August | 6⅞ | 8½ | 7 | 7½ | 5¼ | 8½ | 7¼ | 8½ |
| September | 8 | 9¼ | 7 | 8½ | 7 | 9 | 8¼ | 9 |
| October | 9 | 10⅛ | 8 | 8½ | 7½ | 9¼ | 9 | 10¼ |
| November | 10⅛ | 10⅜ | 9½ | 10 | 7 | 9¼ | 9½ | 10 |
| December | 10⅜ | 10¾ | 9½ | 10 | 7 | 9½ | 9½ | 10 |
| 1897. | | | | | | | | |
| January | 10¼ | 11¾ | 9 | 10 | 3 | 10 | 9¾ | 10¾ |
| February | 12 | 12¼ | 9 | 10½ | 4 | 11 | 10¾ | 11¾ |
| March | 12¼ | 12¼ | 10 | 10½ | 4 | 11 | 11¼ | 11½ |
| April | 10¼ | 12¼ | 10½ | 11 | 3 | 11 | 11¼ | 11¾ |
| May | 8¼ | 10⅝ | 8½ | 11 | 3 | 10½ | 8¾ | 11½ |
| June | 8 | 8⅜ | 7 | 8 | 3 | 8¼ | 8 | 8½ |
| July | 7½ | 8 | 7 | 8 | 4 | 8¼ | 8 | 8½ |

*Wholesale prices of cheese per pound in leading cities of the United States, 1896–1900*—Continued.

| Date. | New York. September, colored. | | Cincinnati. Factory. | | Chicago. Full cream. | | St. Louis. Full cream. | |
|---|---|---|---|---|---|---|---|---|
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1897.** | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| August | 7¾ | 9¼ | 7 | 9½ | 4 | 9¼ | 8½ | 10¼ |
| September | 9 | 9¾ | 8½ | 9½ | 4 | 9¼ | 9½ | 10¼ |
| October | 8¼ | 9⅛ | 8½ | 9½ | 4 | 8½ | 9½ | 10 |
| November | 8½ | 8¾ | 8½ | 9½ | 3 | 8½ | 9½ | 10 |
| December | 8½ | 8½ | 9 | 9½ | 3 | 8½ | 9½ | 10 |
| **1898.** | | | | | | | | |
| January | 8½ | 8¾ | 9 | 9½ | 3 | 9 | 10 | 10 |
| February | 8½ | 8⅝ | 9 | 9½ | 3 | 9¼ | 10 | 10 |
| March | 8 | 8½ | 8½ | 9½ | 3 | 9¼ | 10 | 10 |
| April | 8 | 9 | 8½ | 9 | 3 | 9¼ | 9 | 10 |
| May | 6⅝ | 8⅝ | 7 | 9 | 5 | 9¼ | 9 | 9½ |
| June | 6¾ | 7¼ | 7 | 7½ | 7¼ | 7¾ | 8 | 8¼ |
| July | 7 | 7¾ | 7 | 8 | 7¾ | 8¼ | 8¼ | 8¼ |
| August | 7 | 7⅝ | 7½ | 9 | 8 | 8½ | 8¼ | 8¾ |
| September | 7¼ | 8½ | 7½ | 9 | 8 | 8½ | 8¾ | 10 |
| October | 8¼ | 8¾ | 8½ | 9½ | 8 | 9½ | 10 | 10 |
| November | 8½ | 9¾ | 9 | 9½ | 9 | 10½ | 10 | 10 |
| December | 9¾ | 10½ | 10 | 11 | 10 | 11 | 10 | 10½ |
| **1899.** | | | | | | | | |
| January | 10½ | 10½ | 10½ | 11½ | 9½ | 11 | 10½ | 11 |
| February | 10½ | 11 | 10½ | 11½ | 9½ | 11 | 11 | 11 |
| March | 11 | 12¼ | 11 | 12¼ | 9¾ | 12 | 11 | 11½ |
| April | 12 | 12¼ | 11½ | 12¼ | 11 | 12¼ | 12½ | 12½ |
| May | 8½ | 12 | 9½ | 12 | 9½ | 11¼ | 10½ | 12½ |
| June | 7½ | 8¾ | 8 | 10 | 8 | 9½ | 9 | 9¾ |
| July | 8 | 9½ | 8½ | 9½ | 8¼ | 9 | 9¼ | 10¼ |
| August | 9¼ | 11¼ | 9 | 11 | 8¾ | 10 | 10¼ | 10½ |
| September | 11¼ | 11¾ | 10¾ | 12 | 10 | 11¾ | 11¾ | 12½ |
| October | 12 | 12¾ | 12 | 12½ | 11¼ | 12¼ | 13 | 13 |
| November | 12½ | 12¾ | 12½ | 12½ | 11 | 12½ | 12 | 13 |
| December | 12¾ | 13 | 12 | 12½ | 11 | 13 | 12½ | 12½ |
| **1900.** | | | | | *Twins.* | | | |
| January | 12¾ | 13 | 12 | 12½ | 8 | 12½ | 12½ | 12½ |
| February | 12¾ | 13¼ | 12 | 12½ | 8½ | 12½ | 12½ | 12½ |
| March | 13¼ | 13½ | 12 | 12½ | 9 | 12½ | 12½ | 12½ |
| April | 11 | 13½ | 12 | 12½ | 8½ | 12½ | 12 | 12½ |
| May | 9¼ | 11 | 9 | 11½ | 8½ | 11½ | 10 | 11¾ |
| June | 9¼ | 10 | 8½ | 9 | 7 | 9¾ | 10 | 10½ |
| July | 9 | 9½ | 8½ | 9½ | 8 | 10¼ | 10½ | 10¾ |
| August | 9¼ | 10⅝ | 8½ | 10½ | 8 | 10¾ | 10¾ | 12 |
| September | 12 | 12¼ | 10 | 10½ | 9½ | 11¼ | 10¼ | 11⅜ |
| October | 10⅝ | 11⅜ | 10½ | 11½ | 10 | 11½ | 11¾ | 12 |
| November | 10¾ | 11 | 10¾ | 11 | 9¾ | 10¾ | 11½ | 11¾ |
| December | 11 | 11½ | 10¾ | 11 | 9¾ | 10½ | 11½ | 11½ |

## HOGS.

There was a good advance recorded for live hogs in 1900, which was well maintained throughout the year and on all markets.

*Wholesale prices of live hogs per 100 pounds in leading cities of the United States, 1896–1900.*

| Date. | Cincinnati. Packing, fair to good. | | St. Louis. | | Chicago. | | Omaha. | |
|---|---|---|---|---|---|---|---|---|
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | | | | | | | | |
| January | $3.60 | $5.45 | $3.15 | $4.15 | $3.35 | $4.45 | $3.35 | $4.05 |
| February | 3.85 | 4.35 | 3.40 | 4.25 | 3.60 | 4.35 | 3.60 | 4.12 |
| March | 3.75 | 4.20 | 3.45 | 4.12 | 3.55 | 4.25 | 3.50 | 3.95 |
| April | 3.35 | 3.80 | 3.15 | 3.80 | 3.05 | 4.15 | 3.10 | 3.75 |
| May | 3.25 | 3.45 | 3.00 | 3.50 | 2.80 | 3.75 | 2.85 | 3.45 |
| June | 3.15 | 3.40 | 2.85 | 3.40 | 2.70 | 3.60 | 2.80 | 3.25 |
| July | 3.25 | 3.55 | 3.00 | 3.50 | 2.60 | 3.65 | 2.62 | 3.30 |

*Wholesale prices of live hogs per 100 pounds in leading cities of the United States, 1896–1900*—Continued.

| Date. | Cincinnati. Packing, fair to good. | | St. Louis. | | Chicago. | | Omaha. | |
|---|---|---|---|---|---|---|---|---|
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | | | | | | | | |
| August | $3.20 | $3.45 | $3.00 | $3.50 | $2.50 | $3.70 | $2.55 | $3.15 |
| September | 3.15 | 3.40 | 2.90 | 3.35 | 2.45 | 3.50 | 2.50 | 3.20 |
| October | 3.20 | 3.45 | 3.00 | 3.50 | 2.55 | 3.65 | 2.75 | 3.45 |
| November | 3.40 | 3.75 | 3.10 | 3.55 | 2.90 | 3.70 | 3.00 | 3.50 |
| December | 3.35 | 3.60 | 3.10 | 3.40 | 2.90 | 3.60 | 3.20 | 3.45 |
| **1897.** | | | | | | | | |
| January | 3.20 | 3.55 | 3.10 | 3.55 | 3.00 | 3.60 | 3.00 | 3.50 |
| February | 3.35 | 3.75 | 3.30 | 3.65 | 3.10 | 3.75 | 3.10 | 3.57½ |
| March | 3.60 | 4.10 | 3.40 | 4.10 | 3.35 | 4.25 | 3.40 | 4.05 |
| April | 3.90 | 4.10 | 3.70 | 4.15 | 3.50 | 4.25 | 3.70 | 4.05 |
| May | 3.60 | 3.95 | 3.40 | 3.90 | 3.25 | 4.05 | 3.30 | 3.85 |
| June | 3.30 | 3.55 | 3.20 | 3.50 | 3.05 | 3.65 | 3.05 | 3.45 |
| July | 3.40 | 3.80 | 3.25 | 3.87½ | 3.05 | 4.00 | 3.10 | 3.65 |
| August | 3.85 | 4.40 | 3.55 | 4.50 | 3.45 | 4.55 | 3.35 | 4.15 |
| September | 4.15 | 4.45 | 3.95 | 4.47½ | 3.60 | 4.65 | 3.60 | 4.17½ |
| October | 3.55 | 4.20 | 3.55 | 4.30 | 3.20 | 4.40 | 3.30 | 4.00 |
| November | 3.05 | 3.55 | 3.30 | 3.65 | 3.15 | 3.80 | 3.17½ | 3.62½ |
| December | 3.00 | 3.40 | 3.35 | 3.47½ | 3.10 | 3.60 | 2.85 | 3.45 |
| **1898.** | | | | | | | | |
| January | 3.40 | 3.90 | 3.25 | 3.90 | 3.35 | 4.00 | 3.35 | 3.80 |
| February | 3.65 | 4.20 | 3.60 | 4.10 | 3.60 | 4.27½ | 3.52½ | 4.00 |
| March | 3.75 | 4.00 | 3.70 | 4.10 | 3.65 | 4.17½ | 3.50 | 3.95 |
| April | 3.65 | 3.95 | 3.60 | 4.10 | 3.60 | 4.15 | 3.50 | 3.90 |
| May | 3.90 | 4.45 | 3.70 | 4.55 | 3.70 | 4.80 | 3.75 | 4.60 |
| June | 3.75 | 4.05 | 3.35 | 4.15 | 3.55 | 4.50 | 3.40 | 4.30 |
| July | 3.70 | 4.00 | 3.30 | 4.05 | 3.60 | 4.17½ | 3.40 | 3.95 |
| August | 3.85 | 4.00 | 3.50 | 4.05 | 3.45 | 4.20 | 3.50 | 3.92½ |
| September | 3.80 | 4.00 | 3.50 | 4.05 | 3.40 | 4.15 | 3.40 | 3.90 |
| October | 3.50 | 3.85 | 3.40 | 3.92½ | 3.25 | 4.00 | 3.35 | 3.80 |
| November | 3.35 | 3.70 | 3.20 | 3.80 | 3.10 | 3.85 | 3.10 | 3.65 |
| December | 3.15 | 3.50 | 3.10 | 3.65 | 3.15 | 3.75 | 3.10 | 4.55 |
| **1899.** | | | | | | | | |
| January | 3.45 | 3.95 | 3.40 | 3.90 | 3.30 | 4.05 | 3.30 | 3.75 |
| February | 3.55 | 4.05 | 3.55 | 4.00 | 3.45 | 4.05 | 3.30 | 3.77½ |
| March | 3.60 | 3.95 | 3.55 | 3.97½ | 3.50 | 4.00 | 3.40 | 3.75 |
| April | 3.70 | 4.00 | 3.65 | 4.12½ | 3.50 | 4.15 | 3.50 | 3.85 |
| May | 3.65 | 3.92 | 3.60 | 3.95 | 3.45 | 4.05 | 3.45 | 3.80 |
| June | 3.65 | 4.00 | 3.60 | 3.90 | 3.45 | 4.00 | 3.25 | 3.75 |
| July | 3.80 | 4.65 | 3.75 | 4.60 | 3.55 | 4.70 | 3.67½ | 4.42½ |
| August | 4.35 | 4.85 | 4.55 | 4.85 | 3.85 | 5.00 | 4.10 | 4.70 |
| September | 4.25 | 4.80 | 4.45 | 4.75 | 3.90 | 4.90 | 4.10 | 4.52½ |
| October | 4.15 | 4.75 | 4.10 | 4.65 | 3.80 | 4.90 | 3.95 | 4.57½ |
| November | 3.75 | 4.20 | 3.75 | 4.20 | 3.55 | 4.35 | 3.60 | 4.12½ |
| December | 3.75 | 4.40 | 3.80 | 4.47½ | 3.50 | 4.45 | 3.70 | 4.20 |
| **1900.** | | | | | | | | |
| January | 4.45 | 4.80 | 4.40 | 4.75 | 3.70 | 4.92½ | 4.15 | 4.72½ |
| February | 4.85 | 5.05 | 4.75 | 5.05 | 3.70 | 5.10 | 4.40 | 4.90 |
| March | 4.95 | 5.25 | 4.85 | 5.45 | 4.00 | 5.52½ | 4.50 | 5.17½ |
| April | 5.25 | 5.85 | 5.45 | 5.75 | 4.25 | 5.85 | 5.00 | 5.62½ |
| May | 5.15 | 5.45 | 5.20 | 5.50 | 4.00 | 5.57½ | 4.50 | 5.40 |
| June | 5.00 | 5.30 | 5.00 | 5.35 | 4.10 | 5.42½ | 4.57½ | 5.25 |
| July | 5.25 | 5.55 | 5.30 | 5.50 | 4.25 | 5.55 | 4.75 | 5.25 |
| August | 5.25 | 5.40 | 5.25 | 5.50 | 3.60 | 5.57½ | 4.75 | 5.25 |
| September | 5.40 | 5.60 | 5.35 | 5.60 | 3.50 | 5.70 | 4.90 | 5.35 |
| October | 4.45 | 5.30 | 4.75 | 5.40 | 3.35 | 5.55 | 4.25 | 5.25 |
| November | 4.65 | 5.00 | 4.70 | 5.00 | 3.40 | 5.10 | 4.30 | 4.97½ |
| December | 4.60 | 5.15 | 4.75 | 4.95 | 4.00 | 5.45 | 4.55 | 5.00 |

## SHEEP AND WOOL.

Prices of sheep have been better since the latter part of 1897 and fairly steady. Prices of wool show a marked decline from the satisfactory figures of the winter of 1899–1900.

*Prices of sheep per 100 pounds in leading cities of the United States, 1896–1900.*

| Date. | Chicago. | | Cincinnati. | | St. Louis. | | Omaha. | |
|---|---|---|---|---|---|---|---|---|
| | Inferior to choice. | | Good to extra. | | Good to choice natives. | | Native. | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | | | | | | | | |
| January | $1.60 | $4.00 | $2.35 | $3.75 | $2.75 | $3.75 | $2.25 | $3.60 |
| February | 2.00 | 4.00 | 2.25 | 3.75 | 2.95 | 3.75 | 2.25 | 3.35 |
| March | 2.50 | 4.00 | 2.65 | 4.00 | 2.95 | 3.65 | 2.25 | 3.40 |
| April | 2.10 | 4.10 | 3.15 | 4.00 | 2.50 | 3.75 | 2.60 | 3.25 |
| May | 2.50 | 4.00 | 2.85 | 3.85 | 2.50 | 3.50 | 2.00 | 3.85 |
| June | 2.25 | 4.30 | 2.75 | 3.60 | 2.50 | 3.50 | 1.50 | 3.75 |
| July | 2.00 | 4.20 | 2.50 | 4.00 | 2.50 | 3.25 | 2.00 | 3.50 |
| August | 1.75 | 3.70 | 2.25 | 3.40 | 2.25 | 3.00 | 2.00 | 3.25 |
| September | 1.50 | 3.50 | 2.25 | 3.50 | 2.00 | 3.00 | 2.25 | 3.35 |
| October | 1.50 | 3.40 | 2.25 | 3.25 | 2.00 | 2.75 | 1.75 | 3.85 |
| November | 1.50 | 3.65 | 2.35 | 3.50 | 2.25 | 3.25 | 2.00 | 3.75 |
| December | 1.50 | 4.00 | 2.65 | 3.75 | 2.75 | 3.75 | 2.25 | 3.25 |
| **1897.** | | | | | | | | |
| January | 2.00 | 4.10 | 3.00 | 4.00 | 2.00 | 3.75 | 2.50 | 3.75 |
| February | 2.00 | 4.20 | 3.35 | 4.50 | 2.75 | 3.75 | 2.15 | 4.50 |
| March | 2.20 | 4.50 | 3.65 | 4.75 | 2.75 | 4.00 | 2.25 | 4.25 |
| April | 2.80 | 5.00 | 4.10 | 5.00 | 2.75 | 4.00 | 2.50 | 5.25 |
| May | 2.50 | 5.00 | 3.65 | 4.75 | 2.50 | 3.75 | 2.00 | 4.75 |
| June | 2.25 | 5.00 | 2.75 | 4.00 | 2.50 | 4.00 | 1.75 | 4.25 |
| July | 2.35 | 4.40 | 2.85 | 3.75 | 2.50 | 3.75 | 2.25 | 4.00 |
| August | 2.35 | 4.20 | 2.75 | 3.75 | 2.50 | 3.50 | 2.50 | 4.00 |
| September | 2.40 | 4.25 | 3.00 | 4.00 | 2.50 | 3.75 | 3.00 | 4.00 |
| October | 2.40 | 4.50 | 2.85 | 4.00 | 2.50 | 4.00 | 2.50 | 4.15 |
| November | 2.75 | 5.00 | 3.25 | 4.50 | 2.75 | 4.00 | 3.00 | 4.35 |
| December | 3.10 | 4.90 | 3.85 | 4.65 | 2.75 | 4.00 | 2.15 | 3.75 |
| **1898.** | | | | | | | | |
| January | 3.10 | 4.80 | 4.00 | 4.65 | 3.00 | 4.80 | 3.00 | 5.25 |
| February | 3.50 | 4.75 | 4.00 | 4.65 | 3.50 | 4.55 | 3.00 | 4.50 |
| March | 3.25 | 4.75 | 3.75 | 4.75 | 3.90 | 4.35 | 2.75 | 4.35 |
| April | 3.25 | 4.85 | 3.50 | 4.65 | 3.20 | 5.00 | 3.00 | 4.70 |
| May | 3.00 | 4.65 | 3.35 | 4.00 | 3.50 | 4.50 | 3.50 | 4.60 |
| June | 3.10 | 5.25 | 3.25 | 4.25 | 4.10 | 4.85 | 3.00 | 5.00 |
| July | 3.25 | 5.25 | 3.15 | 4.15 | 3.50 | 4.75 | 3.25 | 5.00 |
| August | 3.00 | 4.85 | 3.25 | 4.25 | 3.50 | 4.00 | 3.50 | 4.85 |
| September | 3.00 | 4.75 | 3.10 | 4.25 | 3.75 | 4.35 | 3.00 | 4.25 |
| October | 3.00 | 4.70 | 3.25 | 4.25 | 4.00 | 4.60 | 3.00 | 4.50 |
| November | 2.50 | 4.70 | 3.15 | 4.10 | 3.00 | 4.35 | 2.75 | 4.50 |
| December | 2.50 | 4.55 | 3.25 | 4.00 | 3.50 | 4.25 | 2.75 | 4.65 |
| **1899.** | | | | | | | | |
| January | 2.50 | 4.30 | 3.10 | 4.00 | 3.50 | 4.25 | 3.25 | 4.75 |
| February | 2.80 | 4.55 | 3.50 | 4.25 | 3.50 | 4.50 | 3.25 | 4.50 |
| March | 2.90 | 4.80 | 3.40 | 4.25 | 3.75 | 4.75 | 3.25 | 5.00 |
| April | 3.25 | 5.10 | 4.00 | 5.00 | 4.00 | 5.15 | 3.50 | 5.00 |
| May | 3.65 | 5.65 | 4.00 | 5.00 | 4.25 | 5.60 | 3.50 | 5.50 |
| June | 3.25 | 5.55 | 3.40 | 4.35 | 3.75 | 5.35 | 3.00 | 5.25 |
| July | 3.00 | 5.40 | 3.00 | 4.25 | 4.00 | 4.75 | 3.00 | 4.75 |
| August | 2.75 | 5.15 | 2.85 | 4.35 | 3.50 | 4.10 | 3.50 | 4.50 |
| September | 2.75 | 4.70 | 3.00 | 4.00 | 3.50 | 4.25 | 3.25 | 4.40 |
| October | 2.90 | 4.40 | 3.00 | 4.85 | 3.00 | 4.20 | 3.00 | 4.40 |
| November | 2.75 | 4.50 | 3.00 | 3.90 | 3.10 | 4.50 | 3.00 | 4.60 |
| December | 2.75 | 4.80 | 3.00 | 3.90 | 3.25 | 5.10 | 2.75 | 4.60 |
| **1900.** | | | | | | | | |
| January | 2.60 | 5.25 | 3.35 | 4.75 | 4.00 | 5.25 | 3.25 | 5.25 |
| February | 2.75 | 5.90 | 4.00 | 5.75 | 4.75 | 5.50 | 3.50 | 5.75 |
| March | 3.50 | 6.10 | 5.25 | 6.00 | 5.25 | 5.75 | 3.50 | 6.10 |
| April | 3.50 | 6.50 | 5.35 | 6.00 | 5.25 | 6.25 | 3.50 | 6.10 |
| May | 3.50 | 6.00 | 3.00 | 4.75 | 4.50 | 5.50 | 3.50 | 6.00 |
| June | 2.50 | 5.50 | 2.75 | 4.50 | 4.25 | 4.75 | 3.25 | 5.25 |
| July | 2.50 | 4.60 | 2.25 | 4.25 | 3.90 | 4.30 | 3.00 | 4.60 |
| August | 2.50 | 4.65 | 2.00 | 4.25 | 3.50 | 4.25 | 3.00 | 4.60 |
| September | 2.00 | 4.25 | 2.00 | 3.90 | 3.40 | 4.00 | 2.50 | 4.00 |
| October | 2.50 | 4.25 | 1.50 | 4.00 | 3.50 | 4.00 | 2.00 | 4.00 |
| November | 2.25 | 4.35 | 1.25 | 3.75 | 3.50 | 4.00 | 2.00 | 4.25 |
| December | 2.25 | 5.00 | 1.25 | 3.75 | 3.65 | 4.25 | 2.25 | 4.35 |

*Wool product of the United States[1] for 1900, by States.*

| States and Territories. | Number of sheep Apr. 1, 1900. | Average weight of fleece, 1900. | Shrinkage, 1900. | Wool washed and unwashed. | Wool scoured. |
|---|---|---|---|---|---|
| | | *Pounds.* | *Per cent.* | *Pounds.* | *Pounds.* |
| Maine | 247, 168 | 6 | 40 | 1, 483, 008 | 889, 805 |
| New Hampshire | 76, 383 | 6. 50 | 55 | 496, 490 | 223, 421 |
| Vermont | 164, 858 | 6. 75 | 56 | 1, 112, 792 | 489, 629 |
| Massachusetts | 39, 632 | 6 | 48 | 237, 792 | 123, 652 |
| Rhode Island | 10, 364 | 5. 50 | 42 | 57, 002 | 33, 062 |
| Connecticut | 31, 204 | 5. 50 | 41 | 171, 622 | 101, 257 |
| New York | 819, 088 | 6 | 50 | 4, 914, 528 | 2, 457, 264 |
| New Jersey | 41, 654 | 5 | 47 | 208, 270 | 110, 384 |
| Pennsylvania | 777, 677 | 6 | 50 | 4, 666, 062 | 2, 333, 031 |
| Delaware | 12, 239 | 5 | 46 | 61, 195 | 33, 046 |
| Maryland | 133, 341 | 5 | 47 | 666, 705 | 353, 354 |
| Virginia | 358, 072 | 5 | 42 | 1, 790, 360 | 1, 038, 409 |
| North Carolina | 223, 497 | 5 | 43 | 1, 117, 485 | 636, 967 |
| South Carolina | 56, 258 | 5 | 44 | 281, 290 | 157, 523 |
| Georgia | 271, 534 | 4 | 40 | 1, 086, 136 | 651, 682 |
| Florida | 70, 064 | 4 | 42 | 280, 256 | 162, 549 |
| Alabama | 160, 632 | 4 | 40 | 642, 528 | 395, 517 |
| Mississippi | 204, 745 | 4 | 41 | 818, 980 | 483, 199 |
| Louisiana | 105, 621 | 4. 50 | 50 | 475, 295 | 237, 648 |
| Texas | 2, 317, 636 | 6. 25 | 70 | 14, 485, 225 | 4, 345, 567 |
| Arkansas | 103, 836 | 4. 25 | 40 | 441, 303 | 264, 782 |
| Tennessee | 235, 875 | 4. 25 | 40 | 1, 002, 469 | 601, 481 |
| West Virginia | 401, 632 | 5. 50 | 47 | 2, 208, 976 | 1, 170, 757 |
| Kentucky | 514, 643 | 5. 25 | 38 | 2, 701, 876 | 1, 675, 163 |
| Ohio | 2, 754, 499 | 5. 75 | 51 | 15, 838, 369 | 7, 760, 800 |
| Michigan | 1, 340, 456 | 6. 70 | 52 | 8, 981, 055 | 4, 310, 906 |
| Indiana | 647, 399 | 6. 50 | 55 | 4, 250, 094 | 2, 337, 552 |
| Illinois | 616, 037 | 6. 50 | 50 | 4, 004, 241 | 2, 002, 121 |
| Wisconsin | 726, 040 | 6. 50 | 51 | 4, 719, 260 | 2, 312, 437 |
| Minnesota | 409, 157 | 6. 75 | 55 | 2, 761, 809 | 1, 242, 814 |
| Iowa | 586, 644 | 6. 50 | 55 | 3, 813, 186 | 1, 715, 934 |
| Missouri | 570, 128 | 6 | 50 | 3, 420, 768 | 1, 710, 384 |
| Kansas | 270, 716 | 8 | 67 | 2, 165, 728 | 714, 690 |
| Nebraska | 315, 937 | 7. 75 | 65 | 2, 448, 462 | 856, 962 |
| South Dakota | 372, 717 | 6. 50 | 60 | 2, 422, 661 | 969, 064 |
| North Dakota | 362, 512 | 6. 50 | 60 | 2, 356, 328 | 924, 531 |
| Montana | 3, 717, 160 | 7 | 63 | 26, 020, 120 | 9, 627, 444 |
| Wyoming | 2, 780, 546 | 7. 75 | 67 | 21, 549, 231 | 7, 111, 246 |
| Colorado | 2, 128, 508 | 6. 25 | 67 | 13, 303, 175 | 4, 390, 048 |
| New Mexico | 3, 786, 688 | 4. 25 | 54 | 16, 093, 424 | 7, 402, 975 |
| Arizona | 1, 003, 942 | 7. 50 | 72 | 7, 529, 565 | 2, 108, 278 |
| Utah | 2, 261, 917 | 6. 25 | 65 | 14, 136, 981 | 4, 947, 943 |
| Nevada | 612, 387 | 7. 50 | 69 | 4, 592, 903 | 1, 424, 400 |
| Idaho | 2, 576, 240 | 7. 50 | 68 | 19, 321, 800 | 6, 182, 976 |
| Washington | 759, 399 | 8. 50 | 73 | 6, 454, 892 | 1, 742, 821 |
| Oregon | 2, 351, 274 | 8 | 70 | 18, 810, 192 | 5, 643, 058 |
| California | 1, 907, 430 | 7 | 66 | 13, 352, 010 | 4, 539, 683 |
| Oklahoma | 32, 432 | 6. 75 | 65 | 218, 916 | 76, 621 |
| Total | 40, 267, 818 | 6. 46 | 61. 1 | 259, 972, 815 | 101, 024, 837 |
| Pulled wool | | | | 28, 663, 806 | 17, 198, 283 |
| Total product, 1900 | | | | 288, 636, 621 | 118, 223, 120 |

[1] Estimate of S. N. D. North.

## Wool Prices in Boston.

The following table of prices of leading grades of domestic wool in Boston, the principal American wool market, is furnished by a trustworthy authority. The figures represent the highest and lowest prices actually paid for the grades indicated, within the limits of the several months. Where no sale was made of the grade indicated the best bid made by buyers for that grade has been substituted.

It is remarkable that the same period of four years should contain both the lowest range of prices ever paid for American wools and the highest prices since 1883. The lowest prices ever paid for American wool were touched in the last week of August, 1896. The highest prices paid since 1883 were in December, 1899, and January, 1900. The lowest price ever touched by Fine Territory Delaine, scoured (the choicest growth of the trans-Mississippi wools), was 28 cents; the highest since 1883, 75 cents. The lowest price ever touched by Fine Ohio Washed Delaine was 18 cents; the highest since 1883, 40 cents.

The largest year's business ever recorded in the Boston market was in 1897, when the sales amounted to 389,635,000 pounds. The next largest was in 1899, when the total sales amounted to 349,568,500 pounds. In the first of these two record years the sales of domestic and foreign wools in Boston were larger by 130,000,000 pounds, in the second by 77,000,000 pounds than the total wool clip of the United States for the respective years, as estimated by the National Association of Wool Manufacturers. Sales should not be confused with shipments for consumption, which were, naturally, somewhat less. The aggregate sales are, however, a true gauge of the activity of the wool trade in those two years, unquestionably the most prosperous ever known in the history of the trade.

*Range of prices of wool in Boston, monthly, 1896–1900.*

[Cents per pound.]

| Date. | Ohio fine unwashed. | | Indiana quarter-blood, unwashed. | | Ohio XX, washed. | | Ohio No. 1, washed. | | Ohio Delaine, washed. | | Michigan X, washed. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | | | | | | | | | | | | |
| January | 13½ | 14 | 18 | 18½ | 20 | 21 | 21½ | 22 | 21 | 22 | 17 | 17½ |
| February | 13 | 13½ | 17 | 18 | 19 | 20 | 21 | 21½ | 21 | 21 | 16 | 17 |
| March | 13 | 13½ | 17 | 17½ | 19 | 19 | 20 | 21 | 20 | 21 | 15½ | 16 |
| April | 12½ | 13 | 15 | 16½ | 18 | 19 | 19 | 20 | 20 | 20 | 15 | 15½ |
| May | 12 | 12½ | 14½ | 15 | 18 | 18 | 17½ | 18½ | 19 | 20 | 15 | 15 |
| June | 12 | 12 | 14 | 14½ | 17 | 18 | 17 | 18 | 19 | 19 | 14½ | 15 |
| July | 12 | 12 | 14 | 14½ | 17 | 18 | 17 | 18 | 19 | 19 | 14 | 14½ |
| August | 12 | 12 | 14 | 14 | 17 | 17½ | 17 | 18 | 18 | 19 | 14 | 14 |
| September | 12½ | 13 | 14 | 15 | 17½ | 18 | 18 | 19 | 19 | 19 | 14 | 15 |
| October | 13 | 14 | 15 | 16 | 18 | 19 | 19 | 21 | 19 | 20 | 15 | 16 |
| November | 14 | 15 | 16½ | 17½ | 19 | 20 | 20 | 21 | 20 | 21 | 16 | 17 |
| December | 13 | 14½ | 16 | 17½ | 19 | 19 | 19½ | 20½ | 20 | 20½ | 16½ | 17 |
| **1897.** | | | | | | | | | | | | |
| January | 13½ | 14½ | 16½ | 17½ | 19 | 20 | 21 | 22 | 20 | 20½ | 16½ | 17 |
| February | 14 | 14½ | 17 | 17½ | 20 | 20½ | 21 | 22 | 20 | 21 | 16½ | 17 |
| March | 14½ | 15 | 17½ | 19½ | 20½ | 22 | 22 | 22 | 21 | 23 | 17 | 18 |
| April | 15 | 16 | 19½ | 20 | 22 | 22½ | 23 | 24 | 23 | 23 | 18 | 18½ |
| May | 16 | 16 | 17¾ | 20 | 22 | 23 | 23 | 24 | 23 | 23 | 18 | 18½ |
| June | 16 | 16½ | 18 | 19 | 22 | 23 | 22 | 23 | 23 | 24 | 18 | 18½ |
| July | 16 | 17 | 20 | 23 | 24 | 25 | 23 | 26 | 24 | 26 | 19 | 20 |
| August | 17 | 19 | 21 | 23 | 25 | 26 | 26 | 27 | 26 | 27 | 20 | 21½ |
| September | 19 | 20 | 23 | 24 | 26 | 29 | 27 | 28 | 27 | 30 | 21½ | 23 |
| October | 20 | 21 | 24 | 24 | 29 | 30 | 28 | 30 | 30 | 30 | 23 | 24 |
| November | 20 | 20 | 23½ | 24 | 29 | 30 | 30 | 30 | 30 | 30 | 23 | 24 |
| December | 20 | 20 | 23 | 24 | 29 | 30 | 30 | 30 | 30 | 30 | 23 | 24 |
| **1898.** | | | | | | | | | | | | |
| January | 20 | 21 | 22 | 24 | 30 | 30 | 30 | 31 | 30 | 32 | 24 | 25 |
| February | 20 | 21 | 22 | 23 | 30 | 30 | 30 | 31 | 31 | 31 | 24 | 24 |
| March | 19 | 20 | 22 | 23 | 29 | 30 | 30 | 30 | 30 | 31 | 23 | 24 |
| April | 19 | 19 | 21 | 22 | 29 | 29 | 29 | 30 | 30 | 30 | 22½ | 23 |
| May | 19 | 19 | 21 | 22 | 28 | 29 | 29 | 29 | 29 | 30 | 22½ | 23 |
| June | 19 | 20 | 22 | 23 | 28 | 29 | 29 | 29 | 29 | 29 | 22 | 22½ |
| July | 19 | 19 | 22 | 23 | 28 | 29 | 29 | 29 | 29 | 29 | 22½ | 22½ |
| August | 19 | 20 | 23 | 23 | 29 | 29 | 29 | 30 | 29 | 30 | 22 | 22½ |
| September | 19 | 19 | 22½ | 23 | 28½ | 29 | 29 | 30 | 29 | 30 | 22 | 22½ |
| October | 19 | 19 | 20 | 22 | 28 | 28½ | 29 | 29 | 29 | 29 | 22 | 22 |
| November | 19 | 19 | 20 | 21 | 28 | 28 | 29 | 29 | 29 | 29 | 22 | 22 |
| December | 18 | 19 | 20 | 21 | 27 | 28 | 29 | 30 | 28 | 29 | 21 | 22 |
| **1899.** | | | | | | | | | | | | |
| January | 18 | 19 | 20 | 21 | 27 | 27 | 29 | 29 | 28 | 29 | 21 | 21 |
| February | 18 | 18½ | 21 | 21 | 26½ | 27 | 29 | 29 | 28 | 28½ | 21 | 21 |
| March | 16 | 17 | 20 | 21 | 25½ | 26 | 28½ | 29 | 27 | 28 | 20 | 21 |
| April | 17 | 18 | 21 | 22 | 26 | 26½ | 29 | 29 | 28 | 28 | 21 | 21 |
| May | 18 | 19 | 22 | 23 | 27 | 27½ | 29 | 29 | 28 | 29 | 21 | 22 |
| June | 19 | 19 | 22 | 23 | 27½ | 28 | 29 | 30 | 29 | 31 | 22 | 23 |
| July | 20 | 23 | 23 | 23 | 29 | 32 | 31 | 33 | 32 | 34 | 23 | 25 |
| August | 21 | 23 | 22 | 23 | 31 | 32 | 33 | 34 | 34 | 35 | 24 | 25 |
| September | 22 | 24 | 23 | 24 | 32 | 32 | 34 | 34 | 35 | 35 | 25 | 25 |
| October | 24 | 24 | 24 | 24 | 32 | 33 | 35 | 35½ | 35 | 36 | 25 | 25½ |
| November | 24 | 25 | 25 | 26 | 33 | 37 | 35½ | 37 | 36 | 40 | 26 | 30 |
| December | 25 | 26 | 27 | 28 | 37 | 38 | 37 | 39 | 40 | 40 | 29 | 30 |
| **1900.** | | | | | | | | | | | | |
| January | 25 | 26 | 28 | 29 | 37 | 38 | 38 | 39 | 38 | 40 | 29 | 29 |
| February | 25 | 25 | 28 | 29 | 37 | 37 | 38 | 38 | 38 | 38 | 28 | 29 |
| March | 22 | 23 | 27 | 28 | 34 | 36 | 35 | 37 | 35 | 37½ | 24 | 27 |
| April | 21 | 22 | 26 | 27 | 32 | 34 | 35 | 35 | 35 | 35 | 24 | 24 |
| May | 20 | 21 | 25 | 26 | 31 | 32 | 34 | 35 | 33 | 35 | 24 | 24 |
| June | 19 | 20 | 25 | 25 | 29 | 31 | 32 | 33 | 32 | 33 | 23 | 24 |
| July | 19 | 19 | 24 | 25 | 29 | 29 | 31 | 32 | 31 | 32 | 23 | 23 |
| August | 19 | 19 | 23 | 24 | 28 | 29 | 30 | 31 | 29 | 31 | 22 | 23 |
| September | 18 | 19 | 23 | 24 | 27½ | 28 | 30 | 30 | 29 | 29 | 22 | 22 |
| October | 18 | 19 | 23 | 24 | 27 | 27½ | 28 | 29 | 27½ | 28 | 21½ | 22 |
| November | 18 | 19 | 23 | 24 | 27 | 28 | 28 | 29 | 28 | 30 | 22 | 23 |
| December | 18 | 18 | 23 | 24 | 28 | 28 | 28 | 28 | 29 | 29 | 22 | 22½ |

*Range of prices of wool in Boston, monthly, 1896–1900*—Continued.

[Cents per pound.]

| Date. | Fine selected Territory, staple scoured. | | Fine medium Territory, clothing scoured. | | Texas, 12 months, scoured. | | Fine free fall, Texas or California scoured. | | Pulled, A super, scoured. | | Pulled, B super, scoured. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | | | | | | | | | | | | |
| January | 37 | 38 | 34 | 35 | 35 | 36 | 29 | 30 | 31 | 33 | 27 | 29 |
| February | 36 | 37 | 33 | 34 | 34 | 35 | 28 | 29 | 30 | 32 | 27 | 27½ |
| March | 31 | 35 | 30 | 33 | 33 | 34 | 27 | 28 | 30 | 31 | 25 | 27 |
| April | 32 | 33 | 29 | 30 | 31 | 32 | 25 | 26 | 30 | 30 | 25 | 26 |
| May | 30 | 32 | 28 | 29 | 31 | 32 | 25 | 26 | 30 | 30 | 25 | 26 |
| June | 30 | 32 | 27 | 28 | 30 | 31 | 25 | 25 | 30 | 30 | 25 | 25 |
| July | 30 | 30 | 27 | 28 | 30 | 31 | 25 | 25 | 29 | 30 | 24 | 25 |
| August | 28 | 30 | 25 | 26 | 28 | 30 | 23 | 25 | 28 | 29 | 23 | 25 |
| September | 30 | 31 | 26 | 27 | 29 | 31 | 23 | 25 | 28 | 30 | 24 | 25 |
| October | 31 | 32 | 28 | 30 | 31 | 32 | 23 | 25 | 29 | 31 | 25 | 27 |
| November | 32 | 36 | 30 | 33 | 32 | 34 | 26 | 27 | 30 | 32 | 27 | 28 |
| December | 35 | 37 | 30 | 32 | 32 | 33 | 25 | 26 | 30 | 31 | 26 | 28 |
| **1897.** | | | | | | | | | | | | |
| January | 36 | 37 | 30 | 32 | 33 | 35 | 26 | 29 | 31 | 33 | 28 | 30 |
| February | 36 | 37 | 31 | 32 | 34 | 35 | 28 | 29 | 31 | 33 | 28 | 30 |
| March | 37 | 40 | 32 | 36 | 36 | 37 | 29 | 30 | 33 | 35 | 30 | 32 |
| April | 40 | 41 | 35 | 37 | 37 | 39 | 30 | 31 | 35 | 37 | 32 | 34 |
| May | 39 | 40 | 33 | 35 | 38 | 38 | 30 | 30 | 34 | 35 | 31 | 33 |
| June | 39 | 40 | 34 | 36 | 38 | 39 | 30 | 31 | 33 | 35 | 31 | 33 |
| July | 41 | 47 | 37 | 42 | 40 | 45 | 31 | 34 | 36 | 40 | 33 | 36 |
| August | 47 | 50 | 43 | 45 | 45 | 46 | 34 | 35 | 38 | 40 | 35 | 37 |
| September | 51 | 55 | 45 | 47 | 46 | 52 | 35 | 39 | 40 | 46 | 37 | 42 |
| October | 55 | 58 | 48 | 52 | 52 | 55 | 40 | 45 | 46 | 48 | 42 | 43 |
| November | 55 | 57 | 48 | 50 | 52 | 53 | 43 | 45 | 45 | 48 | 41 | 43 |
| December | 54 | 55 | 48 | 48 | 50 | 52 | 42 | 43 | 45 | 48 | 41 | 42 |
| **1898.** | | | | | | | | | | | | |
| January | 55 | 57 | 49 | 52 | 52 | 53 | 43 | 45 | 45 | 48 | 41 | 43 |
| February | 54 | 56 | 48 | 50 | 50 | 53 | 42 | 45 | 45 | 47 | 40 | 42 |
| March | 50 | 54 | 45 | 48 | 48 | 50 | 39 | 42 | 45 | 47 | 40 | 41 |
| April | 49 | 50 | 44 | 45 | 46 | 48 | 38 | 39 | 45 | 46 | 38 | 40 |
| May | 47 | 50 | 43 | 45 | 47 | 49 | 38 | 39 | 45 | 47 | 38 | 40 |
| June | 47 | 49 | 43 | 45 | 47 | 48 | 38 | 38 | 43 | 45 | 36 | 38 |
| July | 47 | 49 | 45 | 45 | 48 | 48 | 38 | 39 | 45 | 46 | 38 | 40 |
| August | 47½ | 49 | 45 | 46 | 48 | 48 | 38 | 39 | 45 | 46 | 38 | 40 |
| September | 47 | 49 | 45 | 46 | 47 | 48 | 38 | 39 | 45 | 46 | 38 | 40 |
| October | 47 | 48 | 44 | 45 | 46 | 47 | 38 | 39 | 45 | 46 | 36 | 38 |
| November | 47 | 48 | 43 | 44 | 44 | 46 | 35 | 38 | 42 | 45 | 34 | 36 |
| December | 46 | 47 | 42 | 43 | 42 | 44 | 35 | 36 | 40 | 42 | 32 | 34 |
| **1899.** | | | | | | | | | | | | |
| January | 45 | 46 | 40 | 42 | 42 | 44 | 32 | 33 | 40 | 41 | 32 | 33 |
| February | 44 | 45 | 40 | 40 | 42 | 43 | 32 | 33 | 40 | 42 | 32 | 34 |
| March | 42 | 45 | 38 | 40 | 40 | 42 | 30 | 32 | 40 | 40 | 30 | 31 |
| April | 45 | 45 | 40 | 40 | 41 | 42 | 32 | 33 | 40 | 42 | 31 | 34 |
| May | 45 | 47 | 40 | 42 | 43 | 46 | 33 | 37 | 41 | 44 | 33 | 37 |
| June | 48 | 52 | 43 | 47 | 47 | 50 | 38 | 41 | 42 | 45 | 34 | 37 |
| July | 53 | 58 | 48 | 51 | 51 | 55 | 42 | 45 | 44 | 47 | 36 | 38 |
| August | 55 | 58 | 50 | 52 | 53 | 55 | 43 | 45 | 45 | 47 | 36 | 38 |
| September | 56 | 63 | 51 | 55 | 54 | 56 | 44 | 46 | 46 | 48 | 37 | 40 |
| October | 62 | 63 | 54 | 55 | 56 | 58 | 44 | 46 | 47 | 48 | 40 | 42 |
| November | 63 | 72 | 56 | 62 | 59 | 63 | 46 | 52 | 48 | 52 | 43 | 50 |
| December | 72 | 75 | 60 | 62 | 63 | 65 | 50 | 52 | 53 | 57 | 50 | 52 |
| **1900.** | | | | | | | | | | | | |
| January | 73 | 74 | 60 | 62 | 63 | 65 | 52 | 55 | 55 | 57 | 48 | 50 |
| February | 68 | 70 | 58 | 60 | 60 | 62 | 50 | 52 | 55 | 56 | 48 | 49 |
| March | 65 | 67 | 55 | 57 | 58 | 60 | 47 | 50 | 50 | 54 | 46 | 48 |
| April | 63 | 65 | 53 | 55 | 57 | 58 | 47 | 48 | 50 | 52 | 40 | 45 |
| May | 60 | 62 | 51 | 53 | 56 | 57 | 46 | 48 | 47 | 50 | 40 | 42 |
| June | 55 | 60 | 50 | 51 | 53 | 55 | 42 | 46 | 47 | 50 | 40 | 42 |
| July | 53 | 55 | 46 | 50 | 52 | 53 | 41 | 42 | 46 | 47 | 39 | 40 |
| August | 52 | 53 | 46 | 48 | 52 | 52 | 40 | 42 | 45 | 46 | 37 | 40 |
| September | 50 | 52 | 45 | 47 | 50 | 52 | 38 | 40 | 45 | 45 | 36 | 38 |
| October | 50 | 50 | 45 | 45 | 50 | 50 | 38 | 40 | 42 | 45 | 36 | 38 |
| November | 50 | 52 | 45 | 47 | 50 | 50 | 38 | 40 | 43 | 46 | 37 | 40 |
| December | 49 | 50 | 45 | 46 | 48 | 50 | 40 | 40 | 45 | 46 | 37 | 39 |

*Wholesale prices of wool per pound in leading cities of the United States, 1896–1900.*

| Date. | Boston. | | New York. | | Philadelphia. | | St. Louis. | |
|---|---|---|---|---|---|---|---|---|
| | XX Ohio, washed. | | XX Ohio. | | XX Ohio, washed. | | Best tub-washed. | |
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| January | 20 | 21 | 19 | 19 | 18 | 19 | 20 | 21 |
| February | 19 | 20 | 19 | 19 | 18 | 20 | 20 | 21 |
| March | 19 | 19 | 19 | 19 | 18 | 19 | 20 | 20½ |
| April | 18 | 19 | 18½ | 19 | 17½ | 18½ | 18 | 20 |
| May | 18 | 18 | 18½ | 18½ | 17 | 18 | 18 | 18 |
| June | 17 | 18 | 17½ | 17½ | 16 | 18 | 18 | 19 |
| July | 17 | 18 | 17½ | 17½ | 16½ | 18 | 17 | 18½ |
| August | 17 | 17½ | 17½ | 17½ | 16 | 18 | 17 | 17½ |
| September | 17½ | 18 | 17½ | 17½ | 16 | 18 | 17 | 18½ |
| October | 18 | 19 | 17½ | 17½ | 17½ | 18½ | 18 | 19 |
| November | 19 | 20 | 17½ | 17½ | 18½ | 19 | 20 | 21 |
| December | 19 | 19 | 17½ | 17½ | 19 | 21 | 20½ | 21 |
| **1897.** | | | | | | | | |
| January | 19 | 20 | 17½ | 17½ | 19 | 20 | 20½ | 21½ |
| February | 20 | 20½ | 17½ | 17½ | 19 | 20 | 22 | 22 |
| March | 20½ | 22 | 17½ | 17½ | 19 | 20 | 22 | 23½ |
| April | 22 | 22½ | 17½ | 18½ | 20 | 22 | 24 | 24½ |
| May | 22 | 23 | 18½ | 22 | 21 | 22 | 23 | 24 |
| June | 22 | 23 | 22 | 22 | 21 | 22 | 23 | 23½ |
| July | 24 | 25 | 22 | 24 | 22 | 23 | 24 | 24½ |
| August | 25 | 26 | 24 | 25½ | 23 | 25 | 25 | 28½ |
| September | 26 | 29 | 25½ | 28 | 25 | 27 | 28 | 32 |
| October | 29 | 30 | 28 | 30½ | 28 | 29 | 31 | 32 |
| November | 29 | 30 | 29 | 31½ | 29 | 31 | 30 | 31 |
| December | 29 | 30 | 29½ | 30 | 29 | 31 | 30 | 30 |
| **1898.** | | | | | | | | |
| January | 30 | 30 | 30 | 31 | 29 | 30 | 30 | 30 |
| February | 30 | 30 | 30 | 31 | 30 | 31 | 29 | 30 |
| March | 29 | 30 | 30 | 31 | 29½ | 30½ | 28 | 29 |
| April | 29 | 29 | 30 | 31 | 28 | 30 | 27½ | 28 |
| May | 28 | 29 | 29 | 30 | 28 | 29 | 27 | 28 |
| June | 28 | 29 | 29 | 30 | 28 | 29 | 28 | 28 |
| July | 28 | 29 | 29 | 30 | 28 | 29 | 27½ | 28 |
| August | 29 | 29 | 29 | 30 | 28½ | 29½ | 27½ | 28 |
| September | 28½ | 29 | 29 | 30 | 29 | 30 | 27 | 27 |
| October | 28 | 28½ | 29 | 30 | 29 | 30 | 26 | 26½ |
| November | 28 | 28 | 28 | 29 | 28 | 29 | 25½ | 26 |
| December | 27 | 28 | 28 | 29 | 28 | 29 | 26 | 26 |
| **1899.** | | | | | | | | |
| January | 27 | 27 | 28 | 29 | 27 | 28 | 26 | 26 |
| February | 26½ | 27 | 28 | 29 | 26½ | 27 | 26 | 26 |
| March | 25½ | 26 | 28 | 29 | 26½ | 27 | 25½ | 26 |
| April | 26 | 26½ | 28 | 29 | 26 | 27 | 26 | 26 |
| May | 27 | 27½ | 28 | 29 | 25½ | 26½ | 26 | 26½ |
| June | 27½ | 28 | 28 | 29 | 27 | 28 | 27 | 27 |
| July | 29 | 32 | 28 | 29 | 28½ | 30 | 26 | 26½ |
| August | 31 | 32 | 30 | 32 | 29 | 31 | 26½ | 27 |
| September | 32 | 32 | 30 | 32 | 31 | 32 | 26½ | 27½ |
| October | 32 | 33 | 30 | 33 | 32½ | 33½ | 28 | 28½ |
| November | 33 | 37 | 32 | 36 | 33 | 34 | 29 | 32 |
| December | 37 | 38 | 36 | 39 | 35 | 36 | 34 | 35 |
| **1900.** | | | | | | | | |
| January | 37 | 38 | 36 | 39 | 36 | 37 | 29 | 35 |
| February | 37 | 37 | 36 | 39 | 36 | 37 | 35 | 36 |
| March | 34 | 36 | 36 | 39 | 36 | 37 | 33 | 35 |
| April | 32 | 34 | 36 | 37 | 34 | 35 | 33 | 34 |
| May | 31 | 32 | 34 | 37 | 33 | 34 | 33 | 34 |
| June | 29 | 31 | 34 | 36 | 30 | 32 | 28 | 32½ |
| July | 29 | 29 | 28 | 36 | 29 | 32 | 28 | 29 |
| August | 28 | 29 | 28 | 30 | 29 | 30 | 29 | 29 |
| September | 27½ | 28 | 28 | 30 | 28 | 30 | 29 | 29 |
| October | 27 | 27½ | 28 | 30 | 28 | 29 | 29 | 29 |
| November | 27 | 28 | 28 | 30 | 27 | 28 | 29 | 29½ |
| December | 28 | 28 | 28 | 30 | 27 | 28 | 29 | 29½ |

## EGGS.

No considerable change in the price of eggs is recorded for 1900. The exports, 5,920,727 dozens, worth $984,081, were nearly one-half larger than in 1899, and that year showed a similar advance over 1898, while 1898 was more than double 1897, which quadrupled the exports of 1896. The imports, on the other hand, have steadily decreased.

*Wholesale prices of eggs per dozen in leading cities of the United States, 1896–1900.*

| Date. | New York. Average best fresh. | | Cincinnati. | | Chicago. Fresh. | | St. Louis. Average best fresh. | |
|---|---|---|---|---|---|---|---|---|
| | Low. | High. | Low. | High. | Low. | High. | Low. | High. |
| **1896.** | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* | *Cents.* |
| January | 17 | 25 | 14 | 17 | 15½ | 21 | 11 | 17 |
| February | 11 | 17¼ | 10 | 14 | 9½ | 16 | 8¾ | 11½ |
| March | 11 | 11¾ | 8½ | 10 | 9 | 10½ | 8½ | 9 |
| April | 10½ | 12½ | 8½ | 9½ | 9 | 10½ | 7 | 9 |
| May | 10½ | 12 | 7 | 9 | 7½ | 10½ | 6 | 8 |
| June | 11½ | 12½ | 7½ | 8 | 8½ | 11½ | 7 | 8½ |
| July | 11½ | 13 | 7 | 7½ | 9 | 10 | 6 | 8½ |
| August | 12 | 15 | 7½ | 10½ | 9 | 12 | 8 | 10½ |
| September | 15 | 17½ | 11 | 11 | 11½ | 14½ | 9½ | 12 |
| October | 18 | 19 | 12 | 14½ | 14½ | 17½ | 12 | 14 |
| November | 20 | 24 | 14½ | 16½ | 17 | 22 | 14 | 19 |
| December | 19 | 23 | 13½ | 16 | 16 | 22 | 13 | 19 |
| **1897.** | | | | | | | | |
| January | 15 | 22 | 10½ | 12½ | 12 | 20 | 10 | 16 |
| February | 15 | 19 | 12 | 13½ | 13 | 17 | 11 | 14 |
| March | 10 | 15½ | 7½ | 9 | 8½ | 13½ | 7 | 11½ |
| April | 9¼ | 10 | 7 | 8 | 8 | 9 | 7¼ | 8 |
| May | 10 | 12 | 7½ | 8 | 8 | 10 | 7½ | 8 |
| June | 10½ | 11½ | 8 | 8 | 8 | 9 | 7¼ | 8¼ |
| July | 10½ | 13 | 7 | 7 | 8 | 9½ | 6 | 7½ |
| August | 13 | 17 | 7 | 12 | 9½ | 13½ | 7½ | 12 |
| September | 16 | 18½ | 10½ | 13 | 12½ | 13½ | 10 | 13 |
| October | 16 | 19 | 13 | 14 | 13½ | 15 | 12½ | 13 |
| November | 19 | 22 | 15 | 16½ | 15 | 18 | 14 | 17 |
| December | 22½ | 25 | 16½ | 17 | 18 | 22 | 17 | 18 |
| **1898.** | | | | | | | | |
| January | 18 | 24 | 15 | 17½ | 15 | 22 | 12½ | 19 |
| February | 14 | 19 | 12 | 14 | 12½ | 16 | 10¾ | 14 |
| March | 10½ | 15¾ | 8 | 10½ | 8¾ | 12¼ | 8 | 11½ |
| April | 10 | 11¾ | 8 | 9 | 8½ | 10½ | 8 | 9½ |
| May | 10½ | 12 | 9 | 9 | 9 | 11 | 8½ | 9½ |
| June | 10½ | 12½ | 9 | 9 | 9¼ | 11½ | 8¾ | 9 |
| July | 13 | 14 | 9 | 9 | 9 | 11½ | 9 | 9 |
| August | 14½ | 15½ | 9 | 12 | 9 | 12½ | 9 | 13 |
| September | 15½ | 17½ | 12 | 13 | 12 | 14½ | 11½ | 13½ |
| October | 17½ | 20 | 13 | 14 | 13½ | 16½ | 12½ | 15 |
| November | 20 | 24 | 14 | 19 | 17½ | 22 | 15½ | 19 |
| December | 25 | 27 | 19 | 20 | 21 | 26 | 19 | 20 |
| **1899.** | | | | | | | | |
| January | 17 | 29 | 14 | 22 | 15 | 27 | 13½ | 22 |
| February | 19 | 35 | 15 | 24 | 16 | 35 | 13½ | 32 |
| March | 12½ | 30 | 10½ | 18 | 11½ | 20 | 10 | 17 |
| April | 12½ | 14½ | 10½ | 11½ | 11 | 13 | 10 | 11½ |
| May | 13¼ | 16 | 11 | 12 | 10¾ | 13 | 10¼ | 11½ |
| June | 14½ | 15½ | 10 | 11 | 11 | 13¼ | 10 | 11 |
| July | 15 | 16½ | 8½ | 9½ | 10 | 13 | 9 | 10 |
| August | 15 | 18 | 9 | 11½ | 10 | 12½ | 9 | 12 |
| September | 18 | 21 | 12½ | 15 | 11 | 16½ | 11 | 15½ |
| October | 20 | 22 | 15 | 16½ | 15 | 17 | 14 | 15½ |
| November | 21 | 24 | 17 | 17 | 17 | 18 | 16 | 17 |
| December | 21 | 24 | 17 | 17 | 17 | 20 | 17 | 17 |
| **1900.** | | | | | | | | |
| January | 17 | 26 | 15 | 19 | 13¾ | 20 | 12½ | 17½ |
| February | 13½ | 19 | 12½ | 14 | 12 | 16 | 10½ | 14 |
| March | 12 | 17 | 9½ | 14 | 10 | 16 | 8¾ | 15½ |
| April | 12 | 13½ | 9½ | 11 | 10¼ | 11½ | 8¾ | 11¼ |
| May | 12½ | 14½ | 10½ | 11 | 10¾ | 11½ | 9½ | 10 |
| June | 13 | 15 | 10½ | 10½ | 10 | 11½ | 8 | 10 |
| July | 13 | 17 | 9 | 10 | 10½ | 11½ | 7½ | 9½ |
| August | 14 | 18 | 9 | 12 | 11½ | 13½ | 9½ | 11½ |
| September | 12½ | 14 | 11½ | 15 | 13 | 16 | 16 | 19½ |
| October | 19 | 21 | 14 | 15 | 15½ | 17½ | 14 | 16½ |
| November | 20 | 27 | 18 | 20 | 18 | 23 | 16 | 18½ |
| December | 23 | 29 | 18 | 22 | 20 | 26 | 18 | 23 |

## TRANSPORTATION RATES.[1]

*Grain; average rates, in cents per bushel, from St. Louis to New Orleans by river.*

| Year. | Grain in sacks per 100 pounds. | Per bushel. | | | Year. | Grain in sacks per 100 pounds. | Per bushel. | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Wheat in bulk. | Corn and rye. | | | | Wheat in bulk. | Corn and rye. | |
| | | | High water. | Low water. | | | | High water. | Low water. |
| 1866 | ........ | ........ | 9.05 | 10.93 | 1884 | 14 | 6.63 | 5 | 7 |
| 1867 | ........ | ........ | 11.09 | 14.83 | 1885 | 15 | 6.40 | 5 | 7 |
| 1868 | ........ | ........ | 6.23 | 9.84 | 1886 | 16 | 6.50 | 5 | 7 |
| 1869 | ........ | ........ | 6.32 | 8.42 | 1887 | 18.25 | 6 | 5 | 7 |
| 1870 | ........ | ........ | 9.23 | 13.66 | 1888 | 15 | 6.50 | 5 | 7.50 |
| 1871 | ........ | ........ | 6.71 | 16.29 | 1889 | 17.93 | 5.95 | 5 | 7 |
| 1872 | ........ | ........ | 9.79 | 19.04 | 1890 | 15.66 | 6.58 | 5 | 7 |
| 1873 | ........ | ........ | 6.15 | 9.67 | 1891 | 16.28 | 6.88 | 5 | 7.50 |
| 1874 | ........ | ........ | 4.95 | 8.09 | 1892 | 16.87 | 6.50 | 5 | 7 |
| 1875 | ........ | ........ | 4.87 | 10.01 | 1893 | 17.54 | 6.55 | ........ | ........ |
| 1876 | ........ | ........ | 5.02 | 11.30 | 1894 | 17.14 | 5.89 | ........ | ........ |
| 1877 | 20.04 | 8.11 | 7.63 | 8.59 | 1895 | 12.50 | 5.95 | ........ | ........ |
| 1878 | 17.36 | 7.19 | 4.96 | 8.93 | 1896 | 14.55 | 5 | ........ | ........ |
| 1879 | 18 | 7.75 | 5 | 11 | 1897 | 15 | 4.98 | ........ | ........ |
| 1880 | 19 | 8.25 | 7 | 9.50 | 1898 | 10 | 4.50 | ........ | ........ |
| 1881 | 20 | 6 | 4 | 8 | 1899 | 10 | 4.50 | ........ | ........ |
| 1882 | 20 | 6.42 | 5.50 | 7 | 1900 | 10 | 4.25 | ........ | ........ |
| 1883 | 17.75 | 5.50 | 5 | 7 | | | | | |

*Miscellaneous commodities, New York to Chicago by rail.*[2]

AVERAGE RATES FOR LESS THAN CARLOAD QUANTITIES, IN CENTS PER 100 POUNDS.

| Year. | Furniture. | Agricultural implements. | Lead. | Bagging. | Crockery and earthenware. | Coffee. | Starch. | Sugar. | Molasses. | Rice. | Soap. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Castile and fancy. | Common. |
| 1875 | 53 | ........ | 25 | 48 | 29 | 24 | 40 | 24 | 41 | 25 | 48 | 33 |
| 1876 | 39 | ........ | 20 | 37 | 20 | 20 | 32 | 20 | 23 | 20 | 37 | 23 |
| 1877 | 72 | ........ | 33 | 56 | 33 | 33 | 50 | 33 | 40 | 33 | 65 | 40 |
| 1878 | 77 | ........ | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 62 | 41 |
| 1879 | 75 | ........ | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 60 | 40 |
| 1880 | 75 | ........ | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 60 | 40 |
| 1881 | 65 | ........ | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 51 | 33 |
| 1882 | 56 | ........ | 26 | 26 | 26 | 26 | 26 | 24 | 24 | 26 | 44 | 26 |
| 1883 | 75 | ........ | 35 | 35 | 35 | 35 | 35 | 30 | 30 | 35 | 60 | 35 |
| 1884 | 75 | ........ | 35 | 35 | 35 | 35 | 35 | 25 | 25 | 35 | 60 | 35 |
| 1885 | 56 | ........ | 27 | 27 | 27 | 27 | 27 | 20 | 20 | 27 | 45 | 27 |
| 1886 | 75 | ........ | 35 | 35 | 35 | 35 | 35 | 25 | 25 | 35 | 60 | 35 |
| 1887 | 75 | ........ | 35 | 46 | 35 | 35 | 35 | 33 | 33 | 35 | 64 | 35 |
| 1888 | 73 | 49 | 35 | 49 | 35 | 35 | 35 | 35 | 35 | 35 | 63 | 35 |
| 1889 | 75 | 50 | 35 | 50 | 35 | 35 | 35 | 35 | 35 | 35 | 65 | 35 |
| 1890 | 75 | 50 | 35 | 50 | 35 | 35 | 35 | 35 | 35 | 35 | 65 | 35 |
| 1891 | 75 | 50 | 35 | 50 | 35 | 35 | 35 | 35 | 35 | 35 | 49 | 35 |
| 1892 | 75 | 50 | 35 | 50 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| 1893 | 75 | 50 | 35 | 50 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| 1894 | 75 | 50 | 35 | 50 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| 1895 | 75 | 50 | 35 | 50 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| 1896 | 75 | 50 | 35 | 50 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| 1897 | 75 | 50 | 35 | 50 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| 1898 | 75 | 50 | 35 | 50 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| 1899 | 75 | 50 | 35 | 50 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| 1900 | 75 | 57 | 35 | 57 | 42 | 42 | 42 | 35 | 42 | 35 | 42 | 42 |

[1] All figures here presented are upon a gold basis, the currency rates in actual use prior to the resumption of specie payments having been reduced to their gold equivalent.

[2] Rates for earlier years for this and succeeding tables of transportation rates can be found in Bulletin 15, Miscellaneous Series, Division of Statistics, Department of Agriculture.

*Miscellaneous commodities, New York to Chicago by rail*—Continued.

AVERAGE RATES FOR CARLOADS, IN CENTS PER 100 POUNDS.

| Year. | Furniture. | Agricultural implements. | Lead. | Bagging. | Crockery and earthenware. | Coffee. | Starch. | Sugar. | Molasses. | Rice. | Soap. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Castile and fancy. | Common. |
| 1875 | 53 | 33 | 25 | 48 | 29 | 24 | 40 | 24 | 41 | 25 | 48 | 33 |
| 1876 | 39 | 23 | 20 | 37 | 20 | 20 | 32 | 20 | 23 | 20 | 37 | 23 |
| 1877 | 72 | 39 | 33 | 56 | 33 | 33 | 50 | 33 | 40 | 33 | 65 | 40 |
| 1878 | 77 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 41 | 62 | 41 |
| 1879 | 75 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 60 | 40 |
| 1880 | 75 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 60 | 40 |
| 1881 | 65 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 33 | 51 | 33 |
| 1882 | 56 | 26 | 26 | 26 | 26 | 26 | 26 | 24 | 24 | 26 | 44 | 26 |
| 1883 | 75 | 36 | 35 | 35 | 35 | 35 | 35 | 30 | 30 | 35 | 60 | 35 |
| 1884 | 75 | 36 | 35 | 35 | 35 | 35 | 35 | 25 | 25 | 35 | 60 | 35 |
| 1885 | 56 | 27 | 27 | 27 | 27 | 27 | 27 | 20 | 20 | 27 | 45 | 27 |
| 1886 | 75 | 35 | 35 | 35 | 35 | 35 | 35 | 25 | 25 | 35 | 60 | 35 |
| 1887 | 67 | 31 | 27 | 35 | 31 | 27 | 27 | 25 | 29 | 35 | 64 | 31 |
| 1888 | 63 | 30 | 25 | 35 | 30 | 25 | 25 | 25 | 30 | 25 | 63 | 30 |
| 1889 | 65 | 30 | 25 | 35 | 30 | 25 | 25 | 25 | 30 | 25 | 65 | 30 |
| 1890 | 65 | 30 | 25 | 35 | 30 | 25 | 25 | 25 | 30 | 25 | 65 | 30 |
| 1891 | 65 | 30 | 25 | 35 | 30 | 25 | 25 | 25 | 30 | 25 | 44 | 26 |
| 1892 | 65 | 30 | 25 | 35 | 30 | 25 | 25 | 25 | 30 | 25 | 25 | 25 |
| 1893 | 65 | 30 | 25 | 35 | 30 | 25 | 25 | 25 | 30 | 25 | 25 | 25 |
| 1894 | 65 | 30 | 25 | 35 | 30 | 25 | 25 | 25 | 30 | 25 | 25 | 25 |
| 1895 | 65 | 30 | 25 | 35 | 30 | 25 | 25 | 25 | 30 | 25 | 25 | 25 |
| 1896 | 65 | 30 | 25 | 35 | 30 | 25 | 25 | 25 | 30 | 25 | 25 | 25 |
| 1897 | 65 | 30 | 25 | 35 | 30 | 25 | 25 | 25 | 30 | 25 | 25 | 25 |
| 1898 | 65 | 30 | 25 | 35 | 30 | 25 | 25 | 25 | 30 | 25 | 25 | 25 |
| 1899 | 65 | 30 | 25 | 35 | 30 | 25 | 25 | 25 | 30 | 25 | 25 | 25 |
| 1900 | 65 | 30 | 25 | 35 | 30 | 30 | 30 | 30 | 30 | 25 | 30 | 30 |

AVERAGE RATES, REGARDLESS OF QUANTITY SHIPPED, IN CENTS PER 100 POUNDS.

| Year. | Dry goods. | Cotton piece goods. | Boots and shoes. | Tea. | Drugs. |
|---|---|---|---|---|---|
| 1875 | 53 | 53 | 53 | 53 | 53 |
| 1876 | 39 | 39 | 39 | 39 | 39 |
| 1877 | 72 | 72 | 72 | 72 | 72 |
| 1878 | 77 | 77 | 77 | 77 | 77 |
| 1879 | 75 | 75 | 75 | 75 | 75 |
| 1880 | 75 | 75 | 75 | 75 | 75 |
| 1881 | 65 | 65 | 65 | 65 | 65 |
| 1882 | 56 | 56 | 56 | 56 | 56 |
| 1883 | 75 | 75 | 75 | 75 | 75 |
| 1884 | 75 | 75 | 75 | 75 | 75 |
| 1885 | 56 | 56 | 56 | 56 | 56 |
| 1886 | 75 | 66 | 75 | 75 | 75 |
| 1887 | 75 | 50 | 75 | 75 | 75 |
| 1888 | 73 | 49 | 73 | 73 | 73 |
| 1889 | 75 | 50 | 75 | 75 | 75 |
| 1890 | 75 | 50 | 75 | 75 | 75 |
| 1891 | 75 | 50 | 75 | 75 | 75 |
| 1892 | 75 | 50 | 75 | 75 | 75 |
| 1893 | 75 | 50 | 75 | 75 | 75 |
| 1894 | 75 | 50 | 75 | 75 | 75 |
| 1895 | 75 | 50 | 75 | 75 | 75 |
| 1896 | 75 | 50 | 75 | 75 | 75 |
| 1897 | 75 | 50 | 75 | 75 | 75 |
| 1898 | 75 | 50 | 75 | 75 | 75 |
| 1899 | 75 | 50 | 75 | 75 | 75 |
| 1900 | 75 | 57 | 75 | 75 | 75 |

*Live stock and dressed meats, Chicago to New York by rail.*

AVERAGE RATES, IN CENTS PER 100 POUNDS.

| Year. | Cattle. | Hogs. | Sheep. | Horses and mules. | Dressed beef. | Dressed hogs. | |
|---|---|---|---|---|---|---|---|
| | | | | | | Refrigerator cars. | Common cars. |
| 1880 | 55 | 43 | 65 | 60 | 83 | .......... | .......... |
| 1881 | 35 | 31 | 61 | 60 | 56 | .......... | .......... |
| 1882 | 36 | 29 | 53 | 60 | 57 | .......... | .......... |
| 1883 | 40 | 32 | 50 | 60 | 64 | .......... | .......... |
| 1884 | 31 | 28 | 44 | 60 | 51 | .......... | .......... |
| 1885 | 31 | 26 | 43 | 60 | 54 | .......... | .......... |
| 1886 | 33 | 30 | 42 | 60 | 61 | 53 | 48 |
| 1887 | 33 | 32 | 40 | 60 | 62 | 59 | 54 |
| 1888 | 22 | 26 | 31 | 60 | 46 | 46 | 44 |
| 1889 | 25 | 30 | 30 | 60 | 47 | 47 | 45 |
| 1890 | 23 | 28 | 30 | 60 | 39 | 39 | 39 |
| 1891 | 27 | 30 | 30 | 60 | 45 | 45 | 45 |
| 1892 | 28 | 28 | 30 | 60 | 45 | 45 | 45 |
| 1893 | 28 | 20 | 30 | 60 | 45 | 45 | 45 |
| 1894 | 28 | 30 | 30 | 60 | 45 | 45 | 45 |
| 1895 | 28 | 30 | 30 | 60 | 45 | 45 | 45 |
| 1896 | 28 | 30 | 30 | 60 | 45 | 45 | 45 |
| 1897 | 28 | 30 | 30 | 60 | 45 | 45 | 45 |
| 1898 | 28 | 30 | 30 | 60 | 45 | 45 | 45 |
| 1899 | [1] 25 | 25 | 25 | 60 | 40 | 40 | 40 |
| 1900 | 28 | 30 | 30 | 60 | 45 | 45 | 45 |

[1] Rates did not go into effect until February 1, 1899. Until that time the 1898 rates governed.

*Meats packed, Cincinnati to New York by rail.*

AVERAGE RATES, IN CENTS, PER 100 POUNDS.

| Year. | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | The year. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1880 | 39.0 | 39.0 | 39.0 | 34.5 | 30.5 | 30.5 | 30.5 | 30.5 | 30.5 | 30.5 | 31.5 | 35.0 | 33.41 |
| 1881 | 35.0 | 35.0 | 35.0 | 30.5 | 30.5 | 25.7 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 26.73 |
| 1882 | ...... | 21.5 | 24.3 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 30.5 | 25.85 |
| 1883 | 30.5 | 30.5 | 30.5 | 29.2 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.7 | 30.5 | 27.83 |
| 1884 | 30.5 | 30.5 | 23.3 | 17.5 | 17.5 | 18.4 | 23.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 24.22 |
| 1885 | 24.4 | 21.5 | 20.0 | 20.6 | 18.5 | 17.5 | 17.5 | 21.5 | 21.5 | 21.5 | 22.8 | 26.0 | 21.10 |
| 1886 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 27.7 | 26.14 |
| 1887 | 30.5 | 30.5 | 30.5 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 27.12 |
| 1888 | 28.0 | 28.5 | 26.3 | 26.0 | 26.0 | 26.0 | 19.9 | 17.3 | 15.5 | 18.8 | 21.5 | 23.6 | 23.11 |
| 1889 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.00 |
| 1890 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 24.8 | 20.0 | 20.0 | 20.0 | 20.0 | 23.89 |
| 1891 | 20.0 | 24.3 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 25.36 |
| 1892 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 25.7 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 21.5 | 23.70 |
| 1893 | 21.5 | 23.7 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 25.43 |
| 1894 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.00 |
| 1895 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.00 |
| 1896 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.00 |
| 1897 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.00 |
| 1898 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.00 |
| 1899 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 21.5 | 21.5 | 21.5 | 24.83 |
| 1900 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.0 | 26.00 |

*Average freight rates, in cents per ton per mile.*

| Year. | Fitchburg R. R. | Boston and Albany R. R. | New York Central and Hudson River R. R. | Erie R. R. | Lake Shore and Michigan Southern Rwy. | Pennsylvania R. R. | Pittsburg, Fort Wayne and Chicago Rwy. | Chesapeake and Ohio Rwy. | Illinois Central R. R. | Chicago, Rock Island and Pacific Rwy. | Chicago, Milwaukee and St. Paul Rwy. | Chicago and Alton R. R. | Union Pacific Rwy. | Louisville and Nashville R. R. | All railways in the United States. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1875.... | 3.624 | 1.346 | 1.119 | 1.061 | 0.887 | 0.989 | 0.970 | 1.299 | 1.691 | 1.688 | 1.833 | 1.649 | 2.164 | 1.687 | 1.421 |
| 1876.... | 2.218 | 1.139 | .929 | .972 | .722 | .841 | .827 | 1.062 | 1.587 | 1.693 | 1.798 | 1.438 | 2.211 | 1.638 | 1.217 |
| 1877.... | 1.955 | 1.136 | .954 | .898 | .813 | .954 | 1.024 | 1.035 | 1.719 | 1.563 | 1.949 | 1.361 | 2.135 | 1.382 | 1.286 |
| 1878.... | 1.582 | 1.113 | .919 | .960 | .724 | .914 | .867 | .985 | 1.616 | 1.539 | 1.762 | 1.354 | 2.236 | 1.635 | 1.296 |
| 1879.... | 1.299 | 1.100 | .793 | .779 | .641 | .823 | .754 | .860 | 1.523 | 1.429 | 1.704 | 1.054 | 1.991 | 1.528 | 1.153 |
| 1880.... | 1.36 | 1.207 | .879 | .836 | .750 | .918 | ...... | .866 | 1.543 | 1.209 | 1.749 | 1.206 | ...... | 1.594 | 1.232 |
| 1881.... | 1.26 | 1.038 | .783 | .805 | .617 | .857 | .745 | .892 | 1.522 | 1.220 | 1.702 | 1.241 | 2.178 | 1.503 | 1.188 |
| 1882.... | 1.17 | 1.064 | .738 | .749 | .628 | .874 | .752 | .753 | 1.417 | 1.281 | 1.481 | 1.253 | 2.102 | 1.349 | 1.102 |
| 1883.... | 1.19 | 1.197 | .915 | .786 | .728 | .881 | .787 | .722 | 1.433 | 1.170 | 1.391 | 1.128 | 1.913 | 1.323 | 1.205 |
| 1884.... | 1.09 | 1.093 | .834 | .719 | .652 | .804 | .673 | .672 | 1.368 | 1.097 | 1.293 | 1.008 | 1.557 | 1.344 | 1.136 |
| 1885.... | 1.06 | .944 | .688 | .656 | .553 | .695 | .577 | .550 | 1.307 | 1.043 | 1.278 | 1.009 | 1.420 | 1.159 | 1.011 |
| 1886.... | 1.07 | 1.101 | .765 | .659 | .639 | .755 | .692 | .541 | 1.157 | 1.071 | 1.168 | .961 | 1.266 | 1.079 | .999 |
| 1887.... | 1.13 | 1.107 | .782 | .687 | .670 | .730 | .717 | .537 | 1.087 | 1.012 | 1.089 | .946 | 1.213 | 1.075 | .984 |
| 1888.... | 1.116 | 1.099 | .753 | .716 | .861 | .723 | .660 | .541 | 1.068 | .964 | 1.020 | .973 | 1.170 | 1.049 | 1.001 |
| 1889.... | 1.015 | 1.030 | .712 | .644 | .632 | .685 | .69 | .538 | .839 | .971 | 1.067 | .525 | 1.166 | .998 | .922 |
| 1890.... | .995 | 1.105 | .730 | .665 | .644 | .661 | .69 | .561 | .942 | .995 | .995 | .898 | 1.138 | .972 | .941 |
| 1891.... | .991 | 1.089 | .740 | .636 | .630 | .656 | .70 | .525 | .934 | 1.039 | 1.003 | .980 | 1.131 | .968 | .895 |
| 1892.... | .925 | 1.057 | .699 | .614 | .602 | .647 | .67 | .518 | .908 | 1.055 | 1.026 | .973 | 1.080 | .948 | .898 |
| 1893.... | .923 | 1.006 | .701 | .631 | .599 | .620 | .68 | .511 | .845 | 1.039 | 1.026 | .949 | 1.033 | .917 | .878 |
| 1894.... | .895 | .944 | .733 | .621 | .587 | .606 | .65 | .478 | .839 | .989 | 1.037 | .974 | .970 | .876 | .860 |
| 1895.... | .878 | .969 | .726 | .604 | .567 | .565 | .64 | .425 | .808 | 1.084 | 1.075 | .994 | .971 | .831 | .839 |
| 1896.... | .864 | .942 | .668 | .606 | .551 | .563 | .66 | .425 | .745 | 1.017 | 1.003 | .925 | .957 | .806 | .806 |
| 1897.... | .870 | .918 | .679 | .610 | .538 | .561 | .60 | .419 | .671 | .958 | 1.008 | .891 | .962 | .791 | .798 |
| 1898.... | .844 | .839 | .606 | .575 | .530 | .521 | .57 | .369 | .695 | .966 | .972 | .866 | .950 | .743 | .753 |
| 1899.... | .771 | .778 | .586 | .554 | .481 | .469 | .50 | .333 | .655 | .930 | .937 | .800 | .992 | .729 | .724 |

*Average rates, in cents per passenger per mile.*

| Year. | Fitchburg R. R. | Boston and Albany R. R. | New York Central and Hudson River R. R. | Erie R. R. | Lake Shore and Michigan Southern Rwy. | Pennsylvania R. R. | Pittsburg, Fort Wayne and Chicago Rwy. | Chesapeake and Ohio Rwy. | Illinois Central R. R. | Chicago, Rock Island and Pacific Rwy. | Chicago, Milwaukee and St. Paul Rwy. | Chicago and Alton R. R. | Union Pacific Rwy. | Louisville and Nashville R. R. | All railways in the United States. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1875.... | 1.910 | 2.180 | 1.885 | 1.955 | 2.088 | 2.259 | 2.407 | 3.231 | 2.882 | 2.687 | 2.690 | 2.755 | 2.878 | 3.219 | 2.378 |
| 1876.... | 1.864 | 2.099 | 1.693 | 1.859 | 1.846 | 1.819 | 1.830 | 3.322 | 2.804 | 2.626 | 2.805 | 2.614 | 2.974 | 3.018 | 2.183 |
| 1877.... | 1.947 | 2.174 | 1.953 | 1.772 | 2.182 | 2.185 | 2.192 | 3.786 | 2.942 | 2.772 | 2.994 | 2.798 | 3.140 | 3.167 | 2.458 |
| 1878.... | 1.969 | 2.217 | 1.978 | 2.158 | 2.255 | 2.277 | 2.258 | 3.738 | 3.122 | 2.933 | 3.029 | 2.795 | 3.226 | 3.345 | 2.573 |
| 1879.... | 1.888 | 2.137 | 2.044 | 2.090 | 2.221 | 2.253 | 2.228 | 3.630 | 3.066 | 2.971 | 2.908 | 2.417 | ...... | 3.444 | 2.484 |
| 1880.... | 1.885 | 2.096 | 1.999 | 2.041 | 2.135 | 2.222 | 2.156 | 2.959 | 2.514 | 2.806 | 2.868 | 2.076 | ...... | 3.476 | 2.442 |
| 1881.... | 1.820 | 1.970 | 1.862 | 2.016 | 1.988 | 2.152 | 1.895 | 2.989 | 2.164 | 2.666 | 2.856 | 1.828 | 3.341 | 3.168 | 2.446 |
| 1882.... | 1.715 | 1.993 | 1.808 | 1.948 | 2.156 | 2.249 | 2.024 | 2.605 | 2.388 | 2.505 | 2.579 | 1.951 | 3.300 | 2.706 | 2.391 |
| 1883.... | 1.790 | 2.088 | 1.986 | 1.673 | 2.196 | 2.297 | 2.193 | 2.373 | 2.424 | 2.504 | 2.516 | 2.141 | 3.128 | 2.614 | 2.402 |
| 1884.... | 1.651 | 1.908 | 1.942 | 2.189 | 2.170 | 2.258 | 2.222 | 2.379 | 2.225 | 2.572 | 2.553 | 1.900 | 2.952 | 2.342 | 2.323 |
| 1885.... | 1.833 | 1.838 | 1.419 | 1.756 | 2.058 | 1.950 | 1.569 | 2.270 | 2.211 | 2.466 | 2.563 | 2.026 | 2.749 | 2.103 | 2.216 |
| 1886.... | 1.756 | 1.853 | 1.845 | 1.890 | 2.098 | 2.114 | 2.130 | 2.131 | 2.208 | 2.420 | 2.415 | 2.023 | 2.135 | 2.436 | 2.142 |
| 1887.... | 1.89 | 1.880 | 1.989 | 2.039 | 2.260 | 2.125 | 2.255 | 2.074 | 2.268 | 2.328 | 2.538 | 2.062 | 2.301 | 2.394 | 2.245 |
| 1888.... | 1.978 | 1.976 | 1.967 | 1.851 | 2.280 | 2.111 | 2.10 | 2.025 | 2.197 | 2.312 | 2.445 | 2.123 | 2.248 | 2.429 | 2.349 |
| 1889.... | 1.957 | 1.869 | 1.932 | 1.722 | 2.286 | 2.076 | 2.18 | 1.709 | 1.927 | 2.285 | 2.415 | 2.128 | 2.135 | 2.370 | 2.165 |
| 1890.... | 1.915 | 1.858 | 1.910 | 1.584 | 2.254 | 2.094 | 2.25 | 2.056 | 2.022 | 2.149 | 2.359 | 2.004 | 2.045 | 2.403 | 2.167 |
| 1891.... | 1.869 | 1.818 | 1.905 | 1.601 | 2.105 | 2.070 | 2.23 | 2.155 | 2.073 | 2.322 | 2.408 | 2.205 | 2.059 | 2.483 | 2.142 |
| 1892.... | 1.916 | 1.828 | 1.887 | 1.589 | 2.183 | 2.028 | 2.00 | 2.181 | 2.101 | 2.308 | 2.464 | 2.043 | 2.104 | 2.448 | 2.126 |
| 1893.... | 1.869 | 1.835 | 1.832 | 1.551 | 2.195 | 1.968 | 1.98 | 1.989 | 1.999 | 2.095 | 2.414 | 1.981 | 1.987 | 2.432 | 2.108 |
| 1894.... | 1.851 | 1.794 | 1.857 | 1.509 | 2.069 | 1.993 | 2.00 | 1.905 | 1.925 | 1.891 | 2.191 | 1.776 | 1.758 | 2.365 | 1.986 |
| 1895.... | 1.819 | 1.770 | 1.837 | 1.560 | 2.215 | 1.971 | 2.06 | 1.980 | 1.995 | 2.146 | 2.411 | 2.119 | 1.962 | 2.318 | 2.040 |
| 1896.... | 1.769 | 1.752 | 1.838 | 1.641 | 2.148 | 1.950 | 1.88 | 1.952 | 1.979 | 2.108 | 2.375 | 2.117 | 2.075 | 2.187 | 2.019 |
| 1897.... | 1.811 | 1.754 | 1.842 | 1.543 | 2.108 | 1.958 | 2.02 | 1.980 | 1.979 | 2.153 | 2.289 | 2.116 | 2.101 | 2.254 | 2.022 |
| 1898.... | 1.826 | 1.750 | 1.806 | 1.548 | 2.032 | [1] 1.953 | 2.02 | 1.943 | 1.938 | 2.092 | 2.362 | 2.058 | 1.945 | 2.152 | 1.973 |
| 1899.... | 1.800 | 1.744 | 1.766 | 1.468 | 2.074 | [1] 1.937 | 2.02 | 2.222 | 2.189 | 2.025 | 2.337 | 2.055 | 1.897 | 2.224 | 1.925 |

[1] Excludes ferry earnings at Jersey City, N. J.

# IMPORTS AND EXPORTS OF AGRICULTURAL PRODUCTS.

[From Section of Foreign Markets.]

*Agricultural imports of the United States during the five years ended June 30, 1900.*

| Articles imported. | 1896. | | 1897. | | 1898. | | 1899. | | 1900. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. |
| ANIMAL MATTER. | | | | | | | | | | |
| Animals, live: | | | | | | | | | | |
| Cattle....number.. | 217,826 | $1,509,856 | 328,977 | $2,589,857 | 291,589 | $2,913,223 | 199,752 | $2,320,362 | 181,006 | $2,257,694 |
| Horses....do.... | 9,991 | 662,591 | 6,998 | 464,808 | 3,085 | 414,899 | 3,042 | 551,050 | 3,102 | 596,592 |
| Sheep....do.... | 322,692 | 853,530 | 405,633 | 1,019,668 | 392,314 | 1,106,322 | 345,911 | 1,200,081 | 381,792 | 1,365,026 |
| Other, including fowls.... | | 226,500 | | 211,122 | | 239,681 | | 265,032 | | 311,638 |
| Total.... | | 3,252,477 | | 4,285,455 | | 4,674,125 | | 4,336,525 | | 4,530,950 |
| Beeswax....pounds.. | 273,464 | 75,970 | 174,017 | 43,339 | 272,097 | 72,473 | 452,016 | 109,957 | 213,813 | 51,526 |
| Bones, hoofs, and horns: | | | | | | | | | | |
| Bones, crude.... | | 157,946 | | 224,039 | | 492,544 | | 704,959 | | 830,063 |
| Hoofs and horns.... | | 568,445 | | 150,134 | | | | | | |
| Total.... | | 726,391 | | 374,173 | | 492,544 | | 704,959 | | 830,063 |
| Bristles: | | | | | | | | | | |
| Crude....pounds.. | 726 | 1,620 | 630 | 385 | 1,203 | 416 | 21,421 | 12,399 | 27,140 | 22,330 |
| Sorted, bunched, or prepared....do.... | 1,571,804 | 1,433,728 | 1,347,270 | 1,216,794 | 1,533,887 | 1,248,703 | 1,835,156 | 1,445,853 | 2,503,018 | 2,130,537 |
| Total....do.... | 1,572,530 | 1,435,348 | 1,347,900 | 1,217,179 | 1,535,090 | 1,249,119 | 1,856,577 | 1,458,252 | 2,530,158 | 2,152,867 |
| Dairy products: | | | | | | | | | | |
| Butter....do.... | 52,067 | 8,533 | 37,963 | 6 077 | 31,984 | 5,474 | 23,700 | 3,962 | 49,791 | 9,769 |
| Cheese....do.... | 10,728,397 | 1,491,338 | 12,319,122 | 1,668,796 | 10,012,188 | 1,343,173 | 11,826,175 | 1,563,128 | 13,455,990 | 1,761,613 |
| Milk.... | | 62,622 | | 58,467 | | 67,729 | | 52,603 | | 42,686 |
| Total.... | | 1,562,493 | | 1,733,340 | | 1,416,376 | | 1,619,693 | | 1,814,068 |
| Eggs....dozens.. | 947,132 | 88,682 | 580,681 | 47,760 | 166,319 | 8,078 | 225,180 | 21,300 | 135,038 | 8,741 |
| Egg yolks.... | | (1) | | (1) | | (1) | | 11,322 | | 19,594 |
| Feathers and downs, crude.... | | 2,386,804 | | 2,232,908 | | 2,238,955 | | 1,768,092 | | 1,736,458 |
| Fibers, animal: | | | | | | | | | | |
| Silk— | | | | | | | | | | |
| Cocoons....pounds.. | 279,067 | 112,900 | | | 10,492 | 3,999 | 13,537 | 2,288 | 30,004 | 18,235 |
| Raw, or as reeled from the cocoon, pounds.... | 8,000,621 | 26,246,902 | 6,513,612 | 18,496,944 | 10,315,162 | 31,446,800 | 9,691,145 | 31,827,061 | 11,259,310 | 44,549,672 |
| Waste....pounds.. | 1,084,299 | 403,626 | 1,479,832 | 421,339 | 1,762,297 | 659,267 | 1,545,701 | 650,278 | 1,784,404 | 761,853 |
| Total silk....do.... | 9,363,987 | 26,763,428 | 7,993,444 | 18,918,283 | 12,087,951 | 32,110,066 | 11,250,383 | 32,479,627 | 13,073,718 | 45,329,760 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Wools and hair of the camel, goat, alpaca, and other like animals— | | | | | | | | | | |
| Class 1, clothing— | | | | | | | | | | |
| In the grease ... pounds.. | 117,233,440 | 19,448,471 | 176,350,510 | 27,824,507 | 43,061,372 | 7,302,841 | 12,973,444 | 1,948,402 | 37,404,243 | 8,009,985 |
| Scoured ... do.... | | | 24,408,569 | 6,457,149 | 2,381,615 | 666,770 | 3,555 | 552 | | |
| Total class 1 ... do.... | 117,233,440 | 19,448,471 | 200,759,079 | 34,281,656 | 45,442,987 | 7,969,611 | 12,976,999 | 1,948,954 | 37,404,243 | 8,009,985 |
| Class 2, combing— | | | | | | | | | | |
| In the grease ... do.... | 15,756,318 | 3,509,736 | 37,627,967 | 7,119,201 | 4,305,563 | 856,381 | 2,154,232 | 586,865 | 12,631,283 | 2,633,721 |
| Scoured ... do.... | | | 323,523 | 68,419 | 15,310 | 3,218 | 1,187 | 196 | | |
| Total class 2 ... do.... | 15,756,318 | 3,509,736 | 37,951,490 | 7,187,620 | 4,320,873 | 859,599 | 2,155,419 | 587,061 | 12,631,283 | 2,633,721 |
| Class 3, carpet— | | | | | | | | | | |
| In the grease ... do.... | 97,921,715 | 9,493,035 | 110,665,432 | 11,599,886 | 83,027,666 | 7,954,159 | 61,578,547 | 5,784,444 | 105,892,929 | 9,617,230 |
| Scoured ... do.... | | | 1,476,025 | 174,029 | 3,676 | 323 | 25,244 | 2,438 | | |
| Total class 3 ... do.... | 97,921,715 | 9,493,035 | 112,141,457 | 11,773,915 | 83,031,342 | 7,954,482 | 61,603,791 | 5,786,882 | 105,892,929 | 9,617,230 |
| Total wools ... do.... | 230,911,473 | 32,451,242 | 350,852,026 | 53,243,191 | 132,795,202 | 16,783,692 | 76,736,209 | 8,322,897 | 155,928,455 | 20,260,936 |
| Total animal fibers | ... | 59,214,670 | ... | 72,161,474 | ... | 48,893,758 | ... | 40,802,524 | ... | 65,590,696 |
| Gelatin | ... | 15,386 | ... | 5,748 | ... | 25,907 | ... | 21,961 | ... | 30,361 |
| Glue ... pounds.. | 6,276,926 | 555,979 | 4,926,620 | 472,312 | 4,103,814 | 428,507 | 5,358,063 | 479,450 | 5,577,082 | 537,492 |
| Grease [2] | ... | 1,232,001 | ... | 984,332 | ... | 593,239 | ... | 696,674 | ... | 779,666 |
| Gut | ... | 195,362 | ... | 180,721 | ... | 42,879 | ... | 15,905 | ... | 13,138 |
| Hair | ... | 1,244,077 | ... | 1,330,632 | ... | 1,839,668 | ... | 1,814,964 | ... | 2,445,964 |
| Hide cuttings and other glue stock | ... | 279,692 | ... | 289,686 | ... | 408,262 | ... | 708,968 | ... | 1,223,521 |
| Hides and skins,[3] other than furs: | | | | | | | | | | |
| Goatskins ... pounds.. | 46,747,029 | 10,304,395 | 49,868,020 | 11,328,162 | 64,923,487 | 15,776,601 | 69,728,945 | 18,488,326 | 81,998,818 | 21,987,674 |
| Hides of cattle [4] ... do.... | (1) | (1) | (1) | (1) | 126,243,595 | 13,624,989 | 130,396,020 | 13,621,946 | 163,865,165 | 19,408,217 |
| Other [5] ... do.... | 163,650,982 | 20,215,782 | 156,232,824 | 16,534,864 | 54,607,534 | 7,667,342 | 66,965,785 | 9,877,771 | 100,070,795 | 16,539,807 |
| Total ... do.... | 210,398,011 | 30,520,177 | 206,100,844 | 27,863,026 | 245,774,616 | 37,068,932 | 267,090,750 | 41,988,043 | 345,934,778 | 57,935,698 |
| Honey ... gallons.. | 79,985 | 30,609 | 66,432 | 27,599 | 96,604 | 38,158 | 126,217 | 51,599 | 146,860 | 70,857 |
| Meat products: | | | | | | | | | | |
| Meat and meat extracts | ... | 493,393 | ... | 601,808 | ... | 345,108 | ... | 263,845 | ... | 365,589 |
| Sausage, Bologna ... pounds.. | 359,260 | 80,887 | 328,080 | 76,303 | (1) | 82,546 | (1) | 93,714 | (1) | 95,944 |
| Sausage casings | ... | 588,657 | ... | 542,817 | ... | 537,871 | ... | 622,949 | ... | 646,889 |
| Other [6] | ... | 39,129 | ... | 49,484 | ... | 80,031 | ... | 114,843 | ... | 106,163 |
| Total | ... | 1,202,066 | ... | 1,270,412 | ... | 1,045,556 | ... | 1,095,351 | ... | 1,214,585 |

[1] Not stated.
[2] Prior to July 24, 1897, including tallow, subsequently classed under "Other meat products" (dutiable).
[3] Except sheepskins with the wool on.
[4] Exclusive of hides of cattle from the Hawaiian Islands (free of duty).
[5] Including bird skins and fishskins prior to 1899.
[6] Exclusive of tallow (free of duty) prior to July 24, 1897. In 1899 and 1900, including "Tallow, under reciprocity treaty with Hawaii (free)," of which 142,050 pounds, valued at $5,196, were imported in 1899, and 10,690 pounds, valued at $437, in 1900.

*Agricultural imports of the United States during the five years ended June 30, 1900*—Continued.

| Articles imported. | 1896. | | 1897. | | 1898. | | 1899. | | 1900. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. |
| ANIMAL MATTER—continued. | | | | | | | | | | |
| Oils, animal, except whale and fish, gallons | 37,330 | $12,213 | 38,334 | $6,066 | 14,163 | $5,715 | 9,056 | $1,569 | 18,050 | $3,255 |
| Rennets | ........ | 51,073 | ........ | 60,026 | ........ | 90,757 | ........ | 93,284 | ........ | 66,907 |
| Stearin ........ pounds.. | 523,341 | 37,020 | (1) | (1) | (1) | (1) | 1,865,977 | 25,546 | 1,524,722 | 27,895 |
| Total animal matter | ........ | 104,118,490 | ........ | 114,586,188 | ........ | 100,633,008 | ........ | 97,825,938 | ........ | 141,084,302 |
| VEGETABLE MATTER. | | | | | | | | | | |
| Argols, or wine lees ........ pounds.. | 28,481,665 | 2,724,709 | 23,457,576 | 1,967,042 | 19,202,629 | 1,591,027 | 23,300,762 | 1,914,450 | 27,339,489 | 2,388,693 |
| Breadstuffs: | | | | | | | | | | |
| Barley ........ bushels.. | 837,384 | 317,209 | 1,271,787 | 394,749 | 124,804 | 43,863 | 110,475 | 53,696 | 189,757 | 91,040 |
| Corn (maize) ........ do.... | 4,338 | 1,877 | 6,284 | 2,070 | 3,417 | 1,479 | 4,171 | 1,618 | 2,480 | 1,942 |
| Oats ........ do.... | 47,500 | 18,039 | 46,459 | 12,071 | 9,098 | 3,368 | 11,500 | 4,432 | 41,523 | 18,360 |
| Oatmeal ........ pounds.. | 343,732 | 19,689 | 1,525,409 | 32,742 | 287,910 | 15,697 | 298,764 | 17,740 | 234,959 | 13,499 |
| Rye ........ bushels.. | 154 | 291 | 72 | 170 | 32,938 | 13,323 | 402 | 982 | 330 | 366 |
| Wheat ........ do.... | 2,110,030 | 1,386,161 | 1,534,117 | 1,176,337 | 2,040,590 | 1,948,289 | 1,871,101 | 1,407,625 | 316,968 | 240,496 |
| Wheat flour ........ barrels.. | 1,394 | 6,848 | 2,250 | 9,914 | 2,744 | 12,280 | 905 | 4,057 | 717 | 3,771 |
| Other, and preparations of, used as food. | ........ | 1,035,700 | ........ | 1,146,710 | ........ | 1,113,818 | ........ | 1,054,615 | ........ | 1,434,255 |
| Total | ........ | 2,780,814 | ........ | 2,774,763 | ........ | 3,152,067 | ........ | 2,544,765 | ........ | 1,803,729 |
| Broom corn ........ tons.. | (1) | (1) | (1) | (1) | (1) | (1) | (1) | (1) | 549 | 49,612 |
| Chocolate, other than confectionery and sweetened chocolate ........ pounds.. | 1,145,467 | 198,417 | 1,467,977 | 239,819 | 992,288 | 149,866 | 1,124,515 | 201,439 | 1,209,012 | 240,141 |
| Cider ........ gallons.. | (1) | (1) | (1) | (1) | (1) | (1) | (1) | (1) | 2,647 | 2,287 |
| Cocoa: | | | | | | | | | | |
| Crude, and leaves and shells of. pounds.. | 23,276,597 | 2,387,078 | 31,406,612 | 2,997,866 | 25,717,404 | 3,492,033 | 35,512,364 | 5,064,703 | 41,746,872 | 5,657,283 |
| Prepared or manufactured ...... do.... | 1,244,309 | 410,249 | 1,495,459 | 443,604 | 815,824 | 290,844 | 926,219 | 295,413 | 1,012,368 | 313,561 |
| Total ........ do.... | 24,520,906 | 2,797,327 | 32,902,071 | 3,441,470 | 26,533,228 | 3,782,877 | 36,438,583 | 5,360,116 | 42,759,240 | 5,970,844 |
| Coffee ........ do.... | 580,597,915 | 84,793,124 | 737,645,670 | 81,544,384 | 870,514,455 | 65,067,631 | 831,827,063 | 55,275,470 | 787,991,911 | 52,467,943 |
| Coffee substitutes: | | | | | | | | | | |
| Chicory root— | | | | | | | | | | |
| Raw, unground ........ do.... | 15,841,955 | 210,228 | 16,930,162 | 232,494 | 315,707 | 5,100 | 159,269 | 2,353 | 1,216,518 | 17,762 |
| Roasted, ground, or otherwise prepared ........ pounds.. | 475,933 | 15,849 | 399,008 | 13,899 | (1) | (1) | 335,347 | 11,061 | 384,957 | 12,941 |
| Total chicory root ........ do.... | 16,317,888 | 226,077 | 17,329,170 | 246,393 | (1) | (1) | 494,616 | 13,414 | 1,601,475 | 30,703 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Other.....do.... | 2,366,962 | 90,532 | 2,373,245 | 87,679 | 857,810 | 29,562 | 992,395 | 36,370 | 1,262,659 | 49,029 |
| Total coffee substitutes....do.... | 18,684,850 | 316,609 | 19,702,415 | 334,072 | (1) | (1) | 1,487,011 | 49,784 | 2,864,134 | 79,732 |
| Curry and curry powder..... | ..... | (1) | ..... | (1) | ..... | (1) | ..... | 7,383 | ..... | 8,770 |
| Fibers, vegetable: | | | | | | | | | | |
| Cotton.....pounds.. | 55,350,520 | 6,578,212 | 51,898,926 | 5,884,262 | 52,660,363 | 5,019,503 | 50,158,158 | 5,013,146 | 67,398,521 | 7,960,945 |
| Flax.....tons.. | 7,833 | 1,804,428 | 9,190 | 1,897,976 | 5,529 | 1,193,597 | 6,474 | 1,306,520 | 6,967 | 1,646,274 |
| Hemp.....do.... | 8,450 | 1,069,503 | 5,120 | 639,857 | 4,017 | 560,334 | 3,941 | 477,108 | 3,400 | 450,269 |
| Istle, or Tampico fiber.....do.... | 12,207 | 717,585 | 6,313 | 335,841 | 2,563 | 130,294 | 4,419 | 284,177 | 5,748 | 475,090 |
| Jute and jute butts.....do.... | 88,992 | 2,001,206 | 68,550 | 1,640,484 | 112,306 | 2,543,498 | 83,161 | 2,296,189 | 102,693 | 3,956,413 |
| Manila hemp.....do.... | 47,244 | 3,604,585 | 46,260 | 3,408,322 | 50,270 | 3,239,341 | 53,195 | 6,211,475 | 42,624 | 7,172,368 |
| Sisal grass.....do.... | 52,130 | 3,412,760 | 63,266 | 3,834,732 | 69,322 | 5,169,900 | 71,898 | 9,211,377 | 76,921 | 11,782,263 |
| Other.....do.... | 6,336 | 260,627 | 8,734 | 579,206 | 9,791 | 609,222 | 7,466 | 513,247 | 10,953 | 891,128 |
| Total..... | ..... | 19,448,906 | ..... | 18,220,680 | ..... | 18,465,689 | ..... | 25,313,239 | ..... | 34,334,750 |
| Flowers, natural, preserved or fresh[2]..... | ..... | 10,386 | ..... | 10,334 | ..... | 11,914 | ..... | 19,392 | ..... | 30,621 |
| Fruit juices, n. e. s.: | | | | | | | | | | |
| Prune juice or prune wine...gallons.. | 34,422 | 28,566 | 34,546 | 24,222 | 26,174 | 23,285 | 35,047 | 27,204 | 40,761 | 33,215 |
| Other, including cherry juice...do.... | (1) | 47,285 | (1) | 56,767 | 52,968 | 25,879 | 44,841 | 23,173 | 48,727 | 30,087 |
| Total.....do.... | (1) | 75,851 | (1) | 80,989 | 79,142 | 49,164 | 79,888 | 50,377 | 89,488 | 63,302 |
| Fruits and nuts: | | | | | | | | | | |
| Fruits— | | | | | | | | | | |
| Bananas..... | ..... | 4,502,746 | ..... | 4,086,320 | ..... | 4,236,418 | ..... | 5,665,588 | ..... | 5,877,835 |
| Currants.....pounds.. | 33,040,846 | 551,072 | 29,265,761 | 596,084 | 25,186,210 | 837,987 | 30,849,253 | 798,357 | 36,251,779 | 916,908 |
| Dates.....do.... | 13,680,302 | 273,456 | 11,847,279 | 284,056 | 13,561,434 | 371,992 | 12,943,305 | 324,087 | 19,902,512 | 410,349 |
| Figs.....do.... | 11,900,710 | 639,512 | 8,940,762 | 535,380 | 9,628,426 | 509,002 | 7,284,058 | 356,762 | 8,812,487 | 513,895 |
| Lemons.....do.... | (1) | 5,040,344 | (1) | 4,043,822 | (1) | 2,848,130 | 225,942,718 | 4,398,004 | 160,198,056 | 3,666,881 |
| Oranges.....do.... | (1) | 2,694,131 | (1) | 2,324,907 | (1) | 886,722 | 83,497,669 | 1,097,596 | 68,618,938 | 1,087,041 |
| Plums and prunes.....do.... | 483,658 | 68,862 | 710,028 | 73,303 | 303,992 | 39,660 | 600,360 | 63,574 | 443,457 | 47,700 |
| Raisins.....do.... | 10,826,094 | 460,200 | 12,650,598 | 567,039 | 6,593,833 | 381,889 | 4,933,201 | 282,400 | 10,309,498 | 531,124 |
| Prepared or preserved fruits..... | ..... | 598,928 | ..... | 605,053 | ..... | 922,357 | ..... | 1,020,644 | ..... | 1,243,479 |
| Other[3]..... | ..... | 2,128,056 | ..... | 1,810,807 | ..... | 1,294,855 | ..... | 1,579,652 | ..... | 1,989,546 |
| Total fruits[3]..... | ..... | 16,957,307 | ..... | 14,926,771 | ..... | 12,329,012 | ..... | 15,586,664 | ..... | 16,284,758 |
| Nuts— | | | | | | | | | | |
| Almonds.....pounds.. | 7,789,681 | 763,594 | 9,644,338 | 880,263 | 5,746,362 | 659,659 | 9,957,427 | 1,222,587 | 6,317,633 | 949,083 |
| Cocoanuts..... | ..... | 442,739 | ..... | 471,387 | ..... | 575,935 | ..... | 625,789 | ..... | 702,947 |
| Other[4]..... | ..... | 868,799 | ..... | 848,511 | ..... | 1,002,344 | ..... | 879,166 | ..... | 1,326,804 |
| Total nuts[4]..... | ..... | 2,075,132 | ..... | 2,200,161 | ..... | 2,237,938 | ..... | 2,727,542 | ..... | 2,978,834 |
| Total fruits and nuts..... | ..... | 19,032,439 | ..... | 17,126,932 | ..... | 14,566,950 | ..... | 18,314,206 | ..... | 19,263,592 |

[1] Not stated.
[2] Exclusive of natural flowers free of duty. Since July 24, 1897, all natural flowers imported have been dutiable.
[3] Including nuts free of duty, except cocoanuts.
[4] Exclusive of nuts free of duty, except cocoanuts.

*Agricultural imports of the United States during the five years ended June 30, 1900*—Continued.

| Articles imported. | 1896. | | 1897. | | 1898. | | 1899. | | 1900. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. |
| VEGETABLE MATTER—continued. | | | | | | | | | | |
| Ginger, preserved or pickled.....pounds.. | (1) | $23,547 | (1) | $7,123 | (1) | $14,295 | 142,698 | $6,309 | 429,198 | $17,917 |
| Hay ..............................tons.. | 302,652 | 2,773,535 | 119,942 | 1,030,497 | 3,887 | 34,659 | 19,872 | 115,409 | 143,890 | 1,019,743 |
| Hops ............................pounds.. | 2,772,045 | 600,419 | 3,017,821 | 629,987 | 2,375,922 | 648,155 | 1,319,319 | 591,755 | 2,589,725 | 713,701 |
| Indigo.................................do.... | 3,340,001 | 1,673,170 | 3,522,016 | 1,696,641 | 3,097,340 | 1,815,411 | 3,127,357 | 1,698,583 | 2,746,944 | 1,446,490 |
| Malt, barley.......................bushels.. | 5,579 | 4,774 | 11,084 | 9,384 | 4,769 | 4,412 | 4,984 | 4,447 | 4,399 | 4,127 |
| Malt extract, fluid or solid................. | ............ | 23,889 | ............ | 11,485 | ............ | 6,917 | ............ | 5,320 | ............ | 4,320 |
| Malt liquors: | | | | | | | | | | |
| Bottled ......................gallons.. | 1,038,641 | 1,007,146 | 1,048,994 | 1,025,867 | 733,535 | 695,102 | 918,562 | 917,186 | 1,081,818 | 1,079,723 |
| Unbottled .......................do.... | 2,244,763 | 657,870 | 1,915,650 | 534,426 | 1,777,202 | 506,428 | 1,928,672 | 570,692 | 2,228,502 | 647,533 |
| Total ..........................do.... | 3,283,404 | 1,665,016 | 2,964,644 | 1,560,293 | 2,510,737 | 1,201,530 | 2,847,234 | 1,487,878 | 3,310,320 | 1,727,256 |
| Nursery stock (plants, trees, shrubs, vines, etc.)[2] ............................ | ............ | 955,307 | ............ | 963,977 | ............ | 762,158 | ............ | 768,982 | ............ | 972,385 |
| Oil cake .............................pounds.. | 7,473,016 | 45,725 | 3,098,364 | 20,313 | 2,159,809 | 8,799 | 1,885,648 | 9,553 | 208,657 | 1,437 |
| Oil cake (substitute for india rubber)...... | ............ | (1) | ............ | (1) | ............ | (1) | ............ | 1,149 | ............ | 846 |
| Oils, vegetable: | | | | | | | | | | |
| Fixed or expressed— | | | | | | | | | | |
| Olive, salad...............gallons.. | 942,598 | 1,107,049 | 928,567 | 1,134,077 | 736,877 | 923,804 | 930,042 | 1,090,250 | 967,702 | 1,170,871 |
| Other ............................. | ............ | 2,557,026 | ............ | 2,353,084 | ............ | 2,434,209 | ............ | 2,519,157 | ............ | 3,290,656 |
| Volatile, or essential................. | ............ | 1,554,289 | ............ | 1,885,523 | ............ | 1,511,078 | ............ | 1,691,257 | ............ | 1,859,184 |
| Total................................ | ............ | 5,218,364 | ............ | 5,372,684 | ............ | 4,869,091 | ............ | 5,300,664 | ............ | 6,320,711 |
| Opium: | | | | | | | | | | |
| Crude or unmanufactured....pounds.. | 365,514 | 683,347 | 1,072,914 | 2,184,727 | 123,845 | 265,607 | 513,499 | 1,223,951 | 544,938 | 1,123,756 |
| Prepared .........................do.... | 98,745 | 735,134 | 157,061 | 1,132,861 | 100,258 | 652,341 | 124,214 | 828,203 | 142,479 | 1,065,965 |
| Total ..........................do.... | 464,259 | 1,418,481 | 1,229,975 | 3,317,588 | 224,103 | 917,948 | 637,713 | 2,052,154 | 687,417 | 2,189,721 |
| Rice, rice meal, etc.: | | | | | | | | | | |
| Rice ..........................do.... | 78,190,334 | 1,274,574 | 133,939,930 | 2,555,960 | 129,810,630 | 2,793,111 | 153,837,026 | 3,152,771 | 93,648,451 | 1,904,915 |
| Rice flour, rice meal, and broken rice, pounds.............................. | 68,534,273 | 911,005 | 63,876,204 | 961,200 | 60,474,685 | 953,722 | 50,340,267 | 777,378 | 23,031,440 | 374,121 |
| Total .......................pounds.. | 146,724,607 | 2,185,579 | 197,816,134 | 3,517,160 | 190,285,315 | 3,746,833 | 204,177,293 | 3,930,149 | 116,679,891 | 2,279,036 |
| Sauerkraut.................................. | ............ | 7,895 | ............ | 1,831 | ............ | (1) | ............ | (1) | ............ | (1) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Seeds: | | | | | | | | | | |
| Linseed, or flaxseed ........ bushels.. | 754,507 | 812,940 | 105,222 | 108,871 | 136,098 | 150,515 | 81,953 | 87,602 | 67,379 | 94,126 |
| Other ........ | ........ | 1,870,214 | ........ | 1,315,055 | ........ | 1,081,251 | ........ | 1,134,243 | ........ | 1,700,922 |
| Total ........ | ........ | 2,683,154 | ........ | 1,423,926 | ........ | 1,231,766 | ........ | 1,221,845 | ........ | 1,795,048 |
| Spices: | | | | | | | | | | |
| Unground— | | | | | | | | | | |
| Nutmegs ........ pounds.. | 1,355,420 | 433,436 | 1,669,740 | 451,614 | 1,213,994 | 331,235 | 1,530,102 | 368,765 | 1,590,811 | 351,383 |
| Pepper, black or white ...... do.... | 16,644,763 | 650,861 | 15,033,452 | 711,453 | 14,080,136 | 909,711 | 12,332,747 | 1,083,100 | 13,085,333 | 1,283,635 |
| Other (free of duty) ........ do.... | 19,193,589 | 999,226 | 20,411,490 | 1,076,963 | 13,784,689 | 898,992 | 13,851,055 | 997,783 | 19,652,762 | 1,376,243 |
| Ground (and other dutiable).... do.... | 2,618,214 | 294,996 | 3,030,031 | 336,686 | 2,658,706 | 264,691 | 3,346,925 | 332,653 | 4,516,709 | 390,004 |
| Total ........ do.... | 39,811,986 | 2,378,519 | 40,144,713 | 2,576,716 | 31,737,525 | 2,404,629 | 31,060,829 | 2,782,301 | 38,845,615 | 3,401,265 |
| Spirits, distilled: | | | | | | | | | | |
| Of domestic manufacture, returned, proof gallons ........ | 1,029,653 | 940,060 | 956,760 | 863,558 | 854,586 | 734,901 | 998,173 | 834,948 | 687,024 | 630,574 |
| Brandy ........ proof gallons.. | 259,704 | 690,761 | 337,595 | 911,721 | 137,902 | 395,758 | 219,968 | 626,875 | 244,100 | 696,540 |
| Other ........ do.... | 1,249,895 | 1,446,873 | 1,727,110 | 2,074,835 | 770,830 | 1,004,135 | 1,227,834 | 1,683,256 | 1,550,896 | 2,282,717 |
| Total ........ do.... | 2,539,252 | 3,077,694 | 3,021,465 | 3,850,114 | 1,763,318 | 2,134,794 | 2,445,975 | 3,145,079 | 2,482,020 | 3,609,831 |
| Starch ........ pounds.. | 3,467,399 | 62,756 | 2,941,253 | 51,812 | 6,120,924 | 103,780 | 8,542,897 | 140,528 | 11,767,924 | 222,296 |
| Straw ........ tons.. | 7,879 | 31,140 | 9,386 | 31,768 | 1,448 | 4,463 | 2,075 | 4,564 | 5,495 | 15,750 |
| Sugar and molasses: | | | | | | | | | | |
| Molasses ........ gallons.. | 4,687,664 | 737,265 | 3,702,471 | 586,513 | 3,603,547 | 544,016 | 5,821,556 | 789,576 | 7,025,068 | 890,524 |
| Sugar— | | | | | | | | | | |
| Not No. 16 above Dutch standard— | | | | | | | | | | |
| Beet ........ pounds.. | 604,686,985 | 14,048,914 | 1,865,577,495 | 33,689,158 | 140,641,485 | 2,717,955 | 723,336,352 | 15,269,397 | 701,539,452 | 14,800,609 |
| Cane and other ........ do.... | 3,104,187,781 | 69,817,286 | 2,854,192,069 | 60,448,873 | 2,448,190,703 | 55,319,873 | 3,194,168,454 | 78,001,772 | 3,305,087,796 | 85,059,367 |
| Above No. 16 Dutch standard, pounds ........ | 187,463,791 | 5,353,573 | 199,136,169 | 4,928,150 | 101,088,663 | 2,434,921 | 62,745,763 | 1,692,951 | 11,459,282 | 390,998 |
| Total sugar ........ pounds.. | 3,896,338,557 | 89,219,773 | 4,918,905,733 | 99,066,181 | 2,689,920,851 | 60,472,749 | 3,980,250,569 | 94,964,120 | 4,018,086,530 | 100,250,974 |
| Total sugar and molasses ........ | ........ | 89,957,038 | ........ | 99,652,694 | ........ | 61,016,765 | ........ | 95,753,696 | ........ | 101,141,498 |
| Tea ........ pounds.. | 93,998,372 | 12,704,440 | 113,347,175 | 14,835,862 | 71,957,715 | 10,054,283 | 74,089,899 | 9,675,081 | 84,845,107 | 10,558,110 |
| Tobacco: | | | | | | | | | | |
| Suitable for cigar wrappers ...... do.... | 5,211,852 | 5,596,778 | 6,057,268 | 5,663,214 | 3,988,561 | 3,913,294 | 4,147,043 | 4,349,034 | 5,561,068 | 5,122,359 |
| Other leaf, etc. (including stems), pounds ........ | 27,713,114 | 10,906,352 | 7,747,959 | 3,920,941 | 6,488,547 | 3,575,314 | 9,888,781 | 5,551,219 | 14,058,559 | 8,174,864 |
| Total ........ pounds.. | 32,924,966 | 16,503,130 | 13,805,227 | 9,584,155 | 10,477,108 | 7,488,608 | 14,035,829 | 9,900,253 | 19,619,627 | 13,297,223 |
| Vanilla beans ........ do.... | 235,763 | 1,013,608 | 165,001 | 884,865 | 63,997 | 279,755 | 272,174 | 1,235,412 | 255,966 | 1,209,334 |

[1] Not stated.
[2] Apparently including natural flowers free of duty prior to July 24, 1897.

*Agricultural imports of the United States during the five years ended June 30, 1900*—Continued.

| Articles imported. | 1896. | | 1897. | | 1898. | | 1899. | | 1900. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. |
| VEGETABLE MATTER—continued. | | | | | | | | | | |
| Vegetables: | | | | | | | | | | |
| Beans and peas ........bushels.. | 613,801 | $658,320 | 482,984 | $489,274 | 163,560 | $149,227 | 184,499 | $165,830 | 967,031 | $1,049,443 |
| Cabbages ........number.. | 1,261,696 | 55,644 | 711,033 | 38,906 | (1) | (1) | (1) | (1) | (1) | (1) |
| Onions ........bushels.. | (1) | (1) | 560,138 | 627,273 | 488,853 | 429,173 | 771,960 | 499,520 | 546,798 | 357,901 |
| Potatoes........do.... | 175,240 | 127,595 | 246,178 | 145,584 | 1,171,378 | 473,154 | 530,420 | 294,391 | 155,861 | 147,349 |
| Pickles and sauces........ | ........ | 324,377 | ........ | 332,243 | ........ | 243,354 | ........ | 352,022 | ........ | 306,223 |
| Other— | | | | | | | | | | |
| In their natural state........ | ........ | 683,117 | ........ | 256,752 | ........ | 239,733 | ........ | 312,673 | ........ | 371,963 |
| Prepared or preserved ........ | ........ | 727,797 | ........ | 720,822 | ........ | 499,959 | ........ | 554,302 | ........ | 702,198 |
| Total........ | ........ | 2,576,850 | ........ | 2,610,854 | ........ | 2,034,600 | ........ | 2,178,738 | ........ | 2,935,077 |
| Vinegar ........gallons.. | 81,075 | 24,552 | 76,123 | 20,519 | 85,556 | 22,313 | 93,443 | 23,534 | 122,479 | 30,724 |
| Wafers, unmedicated ........ | ........ | 16,748 | ........ | 20,082 | ........ | 11,797 | ........ | 14,733 | ........ | 15,629 |
| Wines: | | | | | | | | | | |
| Champagne and other sparkling, dozen bottles ........ | 246,393 | 3,628,319 | 228,628 | 3,348,004 | 223,827 | 3,264,323 | 262,371 | 3,668,791 | 310,149 | 4,115,908 |
| Still wines— | | | | | | | | | | |
| Bottled........dozen bottles.. | 314,190 | 1,527,916 | 309,281 | 1,475,211 | 268,921 | 1,312,147 | 274,873 | 1,347,842 | 315,920 | 1,560,851 |
| Unbottled ........gallons.. | 2,834,898 | 1,950,770 | 2,997,952 | 2,039,250 | 1,930,870 | 1,392,710 | 2,253,226 | 1,573,573 | 2,533,828 | 1,744,736 |
| Total........ | ........ | 7,107,005 | ........ | 6,862,465 | ........ | 5,969,180 | ........ | 6,590,206 | ........ | 7,421,495 |
| Total vegetable matter ........ | ........ | 286,910,917 | ........ | 286,285,280 | ........ | 213,658,788 | ........ | 257,688,943 | ........ | 279,054,986 |
| Total agricultural imports........ | ........ | 391,029,407 | ........ | 400,871,468 | ........ | 314,291,796 | ........ | 355,514,881 | ........ | 420,139,288 |

[1] Not stated.

*Agricultural exports (domestic) of the United States during the five years ended June 30, 1900.*

| Articles exported. | 1896. | | 1897. | | 1898. | | 1899. | | 1900. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. |
| ANIMAL MATTER. | | | | | | | | | | |
| Animals, live: | | | | | | | | | | |
| Cattle ........ number.. | 372,461 | $34,560,672 | 392,190 | $36,357,451 | 439,255 | $37,827,500 | 389,490 | $30,516,833 | 397,286 | $30,635,153 |
| Hogs ........ do.... | 21,049 | 227,297 | 28,751 | 295,998 | 14,411 | 110,487 | 33,031 | 227,241 | 51,180 | 394,813 |
| Horses ........ do.... | 25,126 | 3,530,703 | 39,532 | 4,769,265 | 51,150 | 6,176,569 | 45,778 | 5,444,342 | 64,722 | 7,612,616 |
| Mules ........ do.... | 5,918 | 406,161 | 7,473 | 545,331 | 8,098 | 664,789 | 6,755 | 516,908 | 43,369 | 3,919,478 |
| Sheep ........ do.... | 491,565 | 3,076,384 | 244,120 | 1,531,645 | 199,690 | 1,213,886 | 143,286 | 853,555 | 125,772 | 733,477 |
| Other, including fowls ........ | ........ | 39,752 | ........ | 68,771 | ........ | 250,175 | ........ | 322,037 | ........ | 289,494 |
| Total ........ | ........ | 41,840,969 | ........ | 43,568,461 | ........ | 46,243,406 | ........ | 37,880,916 | ........ | 43,585,031 |
| Beeswax ........ pounds.. | 222,612 | 65,844 | 195,048 | 56,462 | 151,094 | 41,827 | 152,494 | 41,916 | 319,379 | 91,913 |
| Bones, hoofs, horns, and horn tips, strips, and waste ........ | ........ | 321,680 | ........ | 280,140 | ........ | 174,861 | ........ | 195,759 | ........ | 199,194 |
| Bristles ........ | ........ | (1) | ........ | 415 | ........ | (1) | ........ | (1) | ........ | 1,446 |
| Dairy products: | | | | | | | | | | |
| Butter ........ pounds.. | 19,373,913 | 2,937,203 | 31,345,224 | 4,493,364 | 25,690,025 | 3,864,765 | 20,247,997 | 3,263,951 | 18,266,371 | 3,143,509 |
| Cheese ........ do.... | 36,777,291 | 3,091,914 | 50,944,617 | 4,636,063 | 53,167,280 | 4,559,324 | 38,198,753 | 3,316,049 | 48,419,353 | 4,943,609 |
| Milk ........ | ........ | 270,453 | ........ | 524,968 | ........ | 671,670 | ........ | 1,049,211 | ........ | 1,139,402 |
| Total ........ | ........ | 6,299,570 | ........ | 9,654,395 | ........ | 9,095,759 | ........ | 7,629,211 | ........ | 9,226,520 |
| Eggs ........ dozens.. | 328,485 | 48,339 | 1,300,183 | 180,954 | 2,754,810 | 448,370 | 3,693,611 | 641,385 | 5,920,727 | 984,081 |
| Egg yolks ........ | ........ | 556 | ........ | (1) | ........ | (1) | ........ | 10,379 | ........ | 883 |
| Feathers: | | | | | | | | | | |
| Ostrich ........ | ........ | 250 | ........ | 5,679 | | | | | | |
| Other ........ pounds.. | 1,165,658 | 193,046 | 1,142,632 | 112,714 | ........ | 157,553 | ........ | 212,374 | ........ | 280,309 |
| Total ........ | ........ | 193,296 | ........ | 118,393 | ........ | 157,553 | ........ | 212,374 | ........ | 280,309 |
| Fertilizer (refuse skins) ........ | ........ | (1) | ........ | (1) | ........ | (1) | ........ | 1,062 | ........ | (1) |
| Glue ........ pounds.. | 1,760,470 | 166,930 | 1,400,863 | 132,581 | 2,318,711 | 209,441 | 2,368,087 | 222,072 | 2,349,014 | 225,844 |
| Grease, grease scraps, and other soap stock. | ........ | 1,516,763 | ........ | 2,070,111 | ........ | 1,964,565 | ........ | 2,576,507 | ........ | 2,944,322 |
| Hair (including manufactures of) ........ | ........ | 455,880 | ........ | 517,469 | ........ | 635,716 | ........ | 503,712 | ........ | 676,688 |
| Hides and skins, other than furs.. pounds.. | 39,545,324 | 3,858,946 | 31,119,166 | 2,388,530 | 11,536,073 | 1,015,032 | 10,140,840 | 929,117 | 7,486,256 | 804,674 |
| Honey ........ | ........ | 90,969 | ........ | 22,368 | ........ | 98,504 | ........ | 55,900 | ........ | 30,191 |
| Meat products: | | | | | | | | | | |
| Beef products— | | | | | | | | | | |
| Beef, canned ........ pounds.. | 63,698,180 | 5,636,953 | 54,019,772 | 4,656,308 | 37,109,570 | 3,279,657 | 38,385,472 | 3,503,293 | 55,553,745 | 5,233,982 |
| Beef, fresh ........ do.... | 224,783,225 | 18,974,107 | 290,395,930 | 22,653,742 | 274,768,074 | 22,966,556 | 282,139,974 | 23,545,185 | 329,078,609 | 29,643,830 |

[1] Not stated.

*Agricultural exports (domestic) of the United States during the five years ended June 30, 1900*—Continued.

| Articles exported. | 1896. | | 1897. | | 1898. | | 1899. | | 1900. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. |
| ANIMAL MATTER—continued. | | | | | | | | | | |
| Meat products—Continued. | | | | | | | | | | |
| Beef products—Continued. | | | | | | | | | | |
| Beef, salted or pickled ... pounds.. | 70,709,209 | $3,975,113 | 67,712,940 | $3,514,126 | 44,314,479 | $2,368,467 | 46,564,876 | $2,525,784 | 47,306,513 | $2,697,340 |
| Beef, other cured ............ do.... | 514,303 | 59,371 | 939,448 | 83,701 | 1,589,052 | 150,051 | 1,579,313 | 145,996 | 2,319,165 | 197,051 |
| Tallow .................... do.... | 52,759,212 | 2,323,764 | 75,108,834 | 2,782,595 | 81,744,809 | 3,141,653 | 107,361,009 | 4,367,356 | 89,030,943 | 4,398,204 |
| Total beef products........ do.... | 412,464,129 | 30,969,308 | 488,176,924 | 33,690,472 | 439,525,984 | 31,906,384 | 476,030,644 | 34,087,614 | 523,288,975 | 42,170,407 |
| Hog products— | | | | | | | | | | |
| Bacon ..................... do.... | 425,352,187 | 33,442,847 | 500,399,448 | 34,187,147 | 650,108,933 | 46,380,918 | 562,651,480 | 41,557,067 | 512,153,729 | 38,975,915 |
| Hams...................... do.... | 129,036,351 | 12,669,763 | 165,247,302 | 15,970,021 | 200,185,861 | 18,987,525 | 225,846,750 | 20,774,084 | 196,411,412 | 20,416,367 |
| Pork, canned ................ do.... | (1) | (1) | (1) | (1) | (1) | (1) | (1) | (1) | 8,496,074 | 658,402 |
| Pork, fresh ................. do.... | 744,656 | 43,739 | 1,306,424 | 94,816 | 12,224,285 | 815,075 | 41,310,364 | 2,722,661 | 25,946,905 | 1,925,772 |
| Pork, salted or pickled...... do.... | 69,498,373 | 3,973,461 | 66,768,920 | 3,297,214 | 88,133,078 | 4,906,961 | 137,197,200 | 7,917,066 | 133,199,683 | 8,243,797 |
| Lard...................... do.... | 509,534,256 | 33,589,851 | 568,315,640 | 29,126,485 | 709,344,045 | 39,710,672 | 711,259,851 | 42,208,465 | 661,813,663 | 41,939,164 |
| Total hog products[2]....... do.... | 1,134,165,823 | 83,719,661 | 1,302,037,734 | 82,675,683 | 1,659,996,202 | 110,801,151 | 1,678,265,645 | 115,179,343 | 1,538,024,466 | 112,159,417 |
| Mutton .................... do.... | 422,950 | 31,793 | 361,955 | 28,341 | 329,169 | 27,961 | 379,110 | 29,427 | 773,760 | 64,313 |
| Oleo and oleomargarin— | | | | | | | | | | |
| Oleo oil.................... do.... | 103,276,756 | 8,087,905 | 113,506,152 | 6,742,061 | 132,579,277 | 7,904,413 | 142,390,492 | 9,183,659 | 146,739,681 | 10,503,856 |
| Oleomargarin (imitation butter), pounds........................ | 6,063,699 | 587,269 | 4,864,351 | 472,856 | 4,328,536 | 386,297 | 5,549,322 | 509,703 | 4,256,067 | 416,544 |
| Total oleo and oleomargarin, pounds........................ | 109,340,455 | 8,675,174 | 118,370,503 | 7,214,917 | 136,907,813 | 8,290,710 | 147,939,814 | 9,693,362 | 150,995,748 | 10,920,400 |
| Poultry and game ................ | ............ | 40,647 | ............ | 72,082 | ............ | 85,739 | ............ | 183,503 | ............ | 463,905 |
| Sausage casings................. | ............ | 1,771,680 | ............ | 1,514,651 | ............ | 1,821,519 | ............ | 1,671,052 | ............ | 2,307,571 |
| Other meat products—[3] | | | | | | | | | | |
| Canned ......................... | ............ | 1,767,437 | ............ | 2,944,486 | ............ | 4,193,078 | ............ | 5,834,865 | ............ | 1,724,064 |
| Other .......................... | | | | | | | | | ............ | 3,941,394 |
| Total meat products ............ | ............ | 126,975,700 | ............ | 128,140,632 | ............ | 157,126,542 | ............ | 166,679,166 | ............ | 173,751,471 |
| Oils, animal, not elsewhere specified: | | | | | | | | | | |
| Lard oil ................ gallons.. | 833,935 | 426,401 | 961,407 | 419,803 | 775,102 | 305,825 | 917,007 | 412,447 | 738,724 | 337,260 |
| Other, except whale and fish.... do.... | 100,934 | 50,839 | 112,555 | 47,836 | 123,711 | 50,587 | 166,372 | 64,368 | 381,161 | 172,568 |
| Total ..................... do.... | 934,869 | 477,240 | 1,073,962 | 467,639 | 898,813 | 356,412 | 1,083,379 | 476,815 | 1,119,885 | 509,828 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Quills | | 27,930 | | 19,264 | | 14,413 | | 12,213 | | 11,105 |
| Rennets, prepared | | 815 | | 735 | | [4] | | [4] | | [4] |
| Silk noils | | 1,958 | | [4] | | [4] | | [4] | | [4] |
| Silk waste ........ pounds.. | 102,624 | 31,163 | 54,060 | 13,181 | 153,886 | 19,002 | 128,698 | 16,075 | 285,640 | 53,851 |
| Silkworm eggs | | 25 | | 25 | | [4] | | [4] | | [4] |
| Stearin ........ pounds.. | 668,585 | 34,289 | 1,388,555 | 70,534 | 3,987,258 | 188,579 | 1,174,167 | 55,821 | [5] | [5] |
| Wool ........ do.... | 6,945,981 | 855,950 | 5,271,535 | 619,932 | 121,139 | 18,071 | 1,683,419 | 237,350 | 2,200,309 | 387,239 |
| Total animal matter | | 183,264,812 | | 188,322,221 | | 217,808,053 | | 218,377,750 | | 233,764,590 |
| VEGETABLE MATTER. | | | | | | | | | | |
| Breadstuffs: | | | | | | | | | | |
| Barley ........ bushels.. | 7,680,331 | 3,100,311 | 20,030,301 | 7,646,384 | 11,237,077 | 5,542,040 | 2,267,403 | 1,375,274 | 23,661,662 | 11,216,694 |
| Bran, middlings, and mill feed .. tons.. | [4] | [4] | [4] | [4] | 91,189 | 1,329,519 | 127,953 | 2,002,588 | 166,604 | 2,638,719 |
| Bread and biscuit ........ pounds.. | 15,426,601 | 694,323 | 15,214,619 | 697,695 | 15,990,558 | 788,264 | 16,447,430 | 809,998 | 18,329,815 | 938,513 |
| Buckwheat ........ bushels.. | [4] | [4] | 1,677,102 | 678,959 | 1,370,403 | 589,285 | 1,533,980 | 846,028 | 426,822 | 254,847 |
| Corn (maize) ........ do.... | 99,992,835 | 37,836,862 | 176,916,365 | 54,087,152 | 208,744,939 | 74,196,850 | 174,089,094 | 68,977,448 | 209,348,284 | 85,206,400 |
| Corn meal ........ barrels.. | 276,885 | 654,121 | 475,263 | 902,061 | 827,651 | 1,766,068 | 791,488 | 1,775,868 | 943,782 | 2,148,410 |
| Oats ........ bushels.. | 13,012,590 | 3,497,611 | 35,096,736 | 8,756,207 | 69,130,288 | 20,632,914 | 30,309,778 | 9,787,540 | 41,369,415 | 12,504,654 |
| Oatmeal ........ pounds.. | 38,592,504 | 939,502 | 47,310,251 | 1,071,340 | 85,500,350 | 1,757,978 | 58,042,505 | 1,295,988 | 66,229,950 | 1,547,900 |
| Rye ........ bushels.. | 988,466 | 445,075 | 8,560,271 | 3,667,505 | 15,541,575 | 8,825,769 | 10,140,866 | 5,936,078 | 2,355,792 | 1,442,055 |
| Rye flour ........ barrels.. | 3,777 | 11,163 | 2,566 | 7,366 | 3,410 | 11,815 | 4,826 | 15,015 | 4,370 | 14,757 |
| Wheat ........ bushels.. | 60,650,080 | 39,709,868 | 79,562,020 | 59,920,178 | 148,231,261 | 145,684,659 | 139,432,815 | 104,269,169 | 101,950,389 | 73,237,080 |
| Wheat flour ........ barrels.. | 14,620,864 | 52,025,217 | 14,569,545 | 55,914,347 | 15,349,943 | 69,263,718 | 18,485,690 | 73,093,870 | 18,699,194 | 67,760,886 |
| Preparations of, for table food } Other | | 2,442,940 | | 4,508,025 | | | | | | |
| Preparations of, for table food | | | | | | 1,765,207 | | 2,133,110 | | 2,362,715 |
| Other | | | | | | 1,743,033 | | 1,681,725 | | 1,470,448 |
| Total | | 141,356,993 | | 197,857,219 | | 333,897,119 | | 273,999,699 | | 262,744,078 |
| Broom corn | | 181.853 | | 136,007 | | 163,066 | | 185,902 | | 182,520 |
| Broom root (rice root) | | [4] | | [4] | | [4] | | 10,975 | | 6,140 |
| Cider ........ gallons.. | 372,986 | 47,670 | 637,672 | 77,695 | 465,873 | 60,063 | 490,803 | 64,500 | 483,367 | 64,283 |
| Coffee and cocoa, ground or prepared, and chocolate | | 107,740 | | 128,078 | | 137,369 | | 192,863 | | 231,509 |
| Compressed food | | [4] | | [4] | | [4] | | [4] | | 74,898 |
| Cotton: | | | | | | | | | | |
| In bales—[6] | | | | | | | | | | |
| Sea-island ........ bales.... | 49,651 | 3,816,216 | 55,347 | 4,078,044 | 40,037 | 2,767,291 | 36,213 | 2,361,697 | 46,308 | 2,985,378 |
| pounds.. | 19,159,469 | | 21,585,360 | | 15,610,302 | | 14,142,052 | | 18,199,967 | |
| Upland and other ........ bales.... | 4,610,114 | 186,240,244 | 6,121,018 | 226,812,927 | 7,540,967 | 227,674,924 | 7,337,169 | 207,203,077 | 6,043,836 | 238,847,359 |
| pounds.. | 2,316,066,916 | | 3,082,169,589 | | 3,834,653,993 | | 3,759,268,241 | | 3,082,383,221 | |
| Total cotton in bales .. bales.... | 4,659,765 | 190,056,460 | 6,176,365 | 230,890,971 | 7,581,004 | 230,442,215 | 7,373,382 | 209,564,774 | 6,090,144 | 241,832,787 |
| pounds.. | 2,335,226,385 | | 3,103,754,949 | | 3,850,264,295 | | 3,773,410,293 | | 3,100,583,188 | |
| Waste cotton ........ pounds.. | [4] | [4] | [4] | [4] | 12,521,574 | 511,004 | 14,308,829 | 524,802 | 25,642,400 | 1,156,241 |
| Total cotton ........ do.... | 2,335,226,385 | 190,056,460 | 3,103,754,949 | 230,890,971 | 3,862,785,869 | 230,953,219 | 3,787,719,122 | 210,089,576 | 3,126,225,588 | 242,988,978 |

[1] Included in "Other meat products."
[2] Prior to 1900, exclusive of canned pork.
[3] Prior to 1900, including canned pork.
[4] Not stated.
[5] Included in "Lard substitutes, n. e. s."
[6] Probably including waste cotton prior to 1898.

*Agricultural exports (domestic) of the United States during the five years ended June 30, 1900*—Continued.

| Articles exported. | 1896. | | 1897. | | 1898. | | 1899. | | 1900. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. |
| VEGETABLE MATTER—continued. | | | | | | | | | | |
| Cotton-seed meats | .......... | (1) | .......... | $37,970 | .......... | (1) | .......... | (1) | .......... | (1) |
| Flowers, cut | .......... | $798 | .......... | 1,429 | .......... | $2,967 | .......... | $2,355 | .......... | $4,169 |
| Fruits and nuts: | | | | | | | | | | |
| Fruits— | | | | | | | | | | |
| Apples, dried ........pounds.. | 26,691,963 | 1,340,507 | 30,775,401 | 1,340,159 | 31,031,254 | 1,897,725 | 19,305,739 | 1,245,733 | 34,964,010 | 2,247,851 |
| Apples, green or ripe......barrels.. | 360,002 | 930,289 | 1,503,981 | 2,371,143 | 605,390 | 1,684,717 | 380,222 | 1,210,459 | 526,636 | 1,444,655 |
| Oranges | .......... | (1) | .......... | (1) | .......... | 339,396 | .......... | 282,313 | .......... | 271,468 |
| Prunes ........pounds.. | (1) | (1) | (1) | (1) | 15,940,791 | 1,021,888 | 5,615,565 | 380,847 | 25,922,371 | 1,646,332 |
| Raisins ........do.... | (1) | (1) | (1) | (1) | 3,109,639 | 167,062 | 4,659,807 | 242,620 | 2,415,456 | 139,689 |
| Other green, ripe, or dried | .......... | 1,868,353 | .......... | 2,172,199 | .......... | 2,033,845 | .......... | 1,997,649 | .......... | 2,545,451 |
| Preserved— | | | | | | | | | | |
| Canned | .......... | 1,376,281 | .......... | 1,686,723 | .......... | 1,624,741 | .......... | 2,330,715 | .......... | 3,127,278 |
| Other | .......... | 70,353 | .......... | 43,276 | .......... | 82,504 | .......... | 66,899 | .......... | 63,448 |
| Total fruits | .......... | 5,585,783 | .......... | 7,613,500 | .......... | 8,851,878 | .......... | 7,757,235 | .......... | 11,486,172 |
| Nuts | .......... | 93,283 | .......... | 125,805 | .......... | 161,432 | .......... | 140,250 | .......... | 156,490 |
| Total fruits and nuts | .......... | 5,679,066 | .......... | 7,739,305 | .......... | 9,013,310 | .......... | 7,897,485 | .......... | 11,642,662 |
| Ginseng ........pounds.. | 199,436 | 770,673 | 179,573 | 840,686 | 174,063 | 638,446 | 196,196 | 782,545 | 160,901 | 833,710 |
| Glucose and grape sugar ........do.... | 171,231,650 | 2,772,335 | 194,419,250 | 2,736,674 | 196,864,605 | 2,871,839 | 229,003,571 | 3,624,890 | 221,901,459 | 3,600,139 |
| Grasses, dried | .......... | 44,583 | .......... | 17,766 | .......... | 26,499 | .......... | 26,063 | .......... | 20,148 |
| Hay ........tons.. | 59,052 | 874,048 | 61,658 | 845,590 | 81,827 | 1,151,273 | 64,916 | 858,992 | 72,716 | 992,741 |
| Hops ........pounds.. | 16,765,254 | 1,478,919 | 11,426,241 | 1,304,183 | 17,161,669 | 2,642,779 | 21,145,512 | 3,626,144 | 12,639,474 | 1,707,660 |
| Lard substitutes, n. e. s. (cottolene, lardine, etc.) [2] ........pounds.. | 1,709,923 | 102,279 | 16,261,991 | 857,708 | 21,343,028 | 1,118,659 | 22,144,717 | 1,200,231 | 25,852,685 | 1,475,064 |
| Malt ........bushels.. | 200,042 | 126,942 | 289,543 | 177,292 | 406,702 | 287,473 | 453,038 | 324,145 | 296,742 | 215,198 |
| Malt sprouts | .......... | (1) | .......... | (1) | .......... | 15,124 | .......... | 55,177 | .......... | 62,266 |
| Malt liquors: | | | | | | | | | | |
| Bottled ........dozen bottles.. | 492,055 | 590,116 | 549,910 | 636,837 | 406,231 | 497,031 | 1,433,799 | 1,733,373 | 1,578,240 | 1,945,059 |
| Unbottled ........gallons.. | 290,383 | 69,759 | 390,048 | 87,112 | 391,802 | 88,548 | 602,055 | 154,751 | 761,411 | 194,157 |
| Total | .......... | 659,875 | .......... | 723,949 | .......... | 585,579 | .......... | 1,888,124 | .......... | 2,139,216 |
| Must | .......... | 18,500 | .......... | (1) | .......... | (1) | .......... | (1) | .......... | (1) |
| Nursery stock | .......... | 133,735 | .......... | 135,047 | .......... | 96,330 | .......... | 134,929 | .......... | 107,172 |
| Oil cake and oil-cake meal: | | | | | | | | | | |
| Corn ........pounds.. | (1) | (1) | (1) | (1) | 2,202,680 | 20,286 | 1,922,264 | 17,623 | 4,888,776 | 48,783 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Cotton-seed ........ do.... | 404,937,291 | 3,740,232 | 623,386,638 | 5,515,800 | 919,727,701 | 8,040,710 | 1,079,993,479 | 9,253,398 | 1,143,704,342 | 11,229,188 |
| Flaxseed, or linseed ........ do.... | 393,429,432 | 4,209,415 | 433,106,448 | 4,095,244 | 436,206,321 | 4,540,824 | 487,177,390 | 5,277,744 | 483,130,182 | 5,528,331 |
| Total[3] ........ do.... | 798,366,723 | 7,949,647 | 1,056,493,086 | 9,611,044 | 1,358,136,702 | 12,601,820 | 1,569,093,133 | 14,548,765 | 1,631,723,300 | 16,806,302 |
| Oils, vegetable: | | | | | | | | | | |
| Corn ........ gallons.. | (1) | (1) | (1) | (1) | 2,646,560 | 575,646 | 2,360,623 | 565,293 | 4,383,926 | 1,351,867 |
| Cotton-seed ........ do.... | 19,445,848 | 5,476,510 | 27,198,882 | 6,897,361 | 40,230,784 | 10,137,619 | 50,627,219 | 12,077,519 | 46,902,390 | 14,127,538 |
| Linseed ........ do.... | 67,159 | 33,260 | 111,262 | 42,700 | 90,074 | 38,439 | 107,000 | 47,681 | 103,494 | 54,148 |
| Volatile, or essential— | | | | | | | | | | |
| Peppermint ........ pounds.. | 85,290 | 174,810 | 162,492 | 257,484 | 145,375 | 180,811 | 117,462 | 118,227 | 89,558 | 90,298 |
| Other ........ | .......... | 102,487 | .......... | 146,569 | .......... | 201,497 | .......... | 162,358 | .......... | 166,424 |
| All other ........ | .......... | 309,955 | .......... | 1,167,504 | .......... | 885,057 | .......... | 838,257 | .......... | 554,781 |
| Total ........ | .......... | 6,097,022 | .......... | 8,511,618 | .......... | 12,019,069 | .......... | 13,809,335 | .......... | 16,345,056 |
| Rice, rice meal, etc.: | | | | | | | | | | |
| Rice ........ pounds.. | 1,346,876 | 14,117 | 387,288 | 14,617 | 637,146 | 27,501 | 852,704 | 38,511 | 12,947,009 | 500,364 |
| Rice bran, meal, and polish ........ do.... | 13,684,678 | 79,637 | 3,518,466 | 20,113 | 5,563,841 | 35,498 | 14,481,985 | 80,298 | 28,119,408 | 167,023 |
| Total ........ do.... | 15,031,554 | 93,754 | 3,905,754 | 34,730 | 6,200,987 | 62,999 | 15,334,689 | 118,809 | 41,066,417 | 667,387 |
| Rice root. (*See* Broom root.) | | | | | | | | | | |
| Root beer ........ dozen quarts.. | (1) | (1) | (1) | (1) | (1) | (1) | (1) | (1) | 3,439 | 4,661 |
| Roots, herbs, and barks, n. e. s ........ | .......... | 153,896 | .......... | 154,347 | .......... | 147,839 | .......... | 169,828 | .......... | 237,527 |
| Seeds: | | | | | | | | | | |
| Cotton ........ pounds.. | 26,980,110 | 179,621 | 26,566,024 | 170,604 | 32,764,781 | 197,258 | 34,443,806 | 197,023 | 49,855,238 | 346,230 |
| Flaxseed, or linseed ........ bushels.. | 80,453 | 73,207 | 4,713,747 | 3,850,835 | 257,228 | 231,237 | 2,830,991 | 2,815,449 | 2,743,266 | 3,475,417 |
| Grass seed— | | | | | | | | | | |
| Clover ........ pounds.. | 5,539,787 | 437,493 | 13,042,994 | 1,003,157 | 31,155,381 | 1,892,101 | 19,980,434 | 1,264,922 | 32,069,371 | 2,379,372 |
| Timothy ........ do.... | 11,894,536 | 518,755 | 16,733,993 | 574,457 | 10,238,780 | 317,173 | 16,149,611 | 492,710 | 15,078,186 | 505,758 |
| Other ........ | .......... | (1) | .......... | (1) | .......... | 167,109 | .......... | 156,200 | .......... | 165,063 |
| Total grass seed ........ | .......... | (1) | .......... | (1) | .......... | 2,376,383 | .......... | 1,913,832 | .......... | 3,050,193 |
| All other seeds ........ | .......... | 382,941 | .......... | 429,379 | .......... | 149,845 | .......... | 153,092 | .......... | 165,142 |
| Total seeds ........ | .......... | 1,592,017 | .......... | 6,028,432 | .......... | 2,954,723 | .......... | 5,079,396 | .......... | 7,036,982 |
| Spices ........ | .......... | 1,367 | .......... | 772 | .......... | 3,841 | .......... | 2,257 | .......... | 19,131 |
| Spirits, distilled: | | | | | | | | | | |
| Alcohol,[4] including cologne spirits, proof gallons ........ | 331,407 | 85,292 | 416,725 | 140,046 | 1,619,280 | 463,616 | 1,476,028 | 427,288 | 177,974 | 59,277 |
| Brandy ........ proof gallons.. | 89,259 | 87,204 | 11,815 | 12,640 | 24,886 | 39,455 | 20,944 | 29,289 | 80,259 | 83,698 |
| Rum ........ do.... | 865,643 | 1,174,093 | 808,393 | 1,102,267 | 607,634 | 845,673 | 850,719 | 1,175,206 | 670,410 | 903,808 |

[1] Not stated.
[2] Including stearin in 1900.
[3] Prior to 1898, exclusive of corn oil cake, of which the exports were inconsiderable.
[4] Including wood alcohol prior to 1898, but not subsequently.

*Agricultural exports (domestic) of the United States during the five years ended June 30, 1900*—Continued.

| Articles exported. | 1896. | | 1897. | | 1898. | | 1899. | | 1900. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. | Quantities. | Values. |
| VEGETABLE MATTER—continued. | | | | | | | | | | |
| Spirits, distilled—Continued. | | | | | | | | | | |
| Whisky— | | | | | | | | | | |
| Bourbon ........... proof gallons.. | 139,866 | $187,336 | 569,413 | $422,451 | 286,599 | $241,066 | 224,918 | $267,865 | 863,241 | $764,860 |
| Rye ........................ do.... | 26,630 | 45,268 | 21,282 | 38,402 | 17,495 | 31,164 | 99,884 | 156,617 | 91,721 | 121,241 |
| Other ........................ do.... | 336,424 | 151,521 | 500,338 | 225,897 | 36,869 | 30,149 | 19,536 | 24,372 | 18,585 | 24,921 |
| Total ........................ do.... | 1,789,229 | 1,730,804 | 2,327,966 | 1,941,703 | 2,592,713 | 1,651,123 | 2,692,029 | 2,080,737 | 1,902,190 | 1,957,805 |
| Starch ........................ pounds.. | 31,829,435 | 885,198 | 79,088,876 | 1,665,926 | 72,806,313 | 1,371,549 | 110,193,776 | 2,292,843 | 124,935,963 | 2,604,362 |
| Straw ........................ | ........ | 5,293 | ........ | 5,659 | ........ | 5,907 | ........ | 4,737 | ........ | 4,200 |
| Sugar, molasses, and sirup: | | | | | | | | | | |
| Molasses and sirup— | | | | | | | | | | |
| Molasses ................ gallons.. | 6,953,307 | 737,870 | 8,913,830 | 788,323 | 3,817,829 | 267,202 | 5,682,080 | 444,392 | 3,892,374 | 434,585 |
| Sirup ........................ do.... | | | | | 7,573,541 | 794,727 | 10,070,650 | 1,465,849 | 11,139,770 | 1,682,202 |
| Total molasses and sirup .. do.... | 6,953,307 | 737,870 | 8,913,830 | 788,323 | 11,391,370 | 1,061,929 | 15,752,730 | 1,910,241 | 15,032,144 | 2,116,787 |
| Sugar— | | | | | | | | | | |
| Brown ................... pounds.. | 296,265 | 10,389 | 1,107,864 | 35,367 | 460,682 | 17,353 | 403,119 | 14,275 | 322,252 | 11,262 |
| Refined ...................... do.... | 9,106,259 | 450,753 | 7,197,355 | 341,641 | 6,047,608 | 301,511 | 9,462,228 | 426,202 | 22,192,351 | 1,004,135 |
| Total sugar ................ do.... | 9,402,524 | 461,142 | 8,305,219 | 377,008 | 6,508,290 | 318,864 | 9,865,347 | 440,477 | 22,514,603 | 1,015,397 |
| Total sugar, molasses, and sirup.. | ........ | 1,199,012 | ........ | 1,165,331 | ........ | 1,380,793 | ........ | 2,350,718 | ........ | 3,132,184 |
| Sugar meal ................... pounds.. | 3,930,412 | 66,935 | [1] | [1] | [1] | [1] | [1] | [1] | [1] | [1] |
| Teazels ........................ | ........ | 6,287 | ........ | 3,336 | ........ | 13,290 | ........ | 19,466 | ........ | 21,882 |
| Tobacco: | | | | | | | | | | |
| Leaf ........................ pounds.. | 287,700,301 | 24,405,245 | 305,978,292 | 24,513,567 | 252,258,902 | 21,924,337 | 272,421,295 | 25,170,771 | 334,604,210 | 29,163,085 |
| Stems and trimmings ........... do.... | 7,839,011 | 166,117 | 8,953,399 | 197,879 | 10,761,312 | 247,243 | 11,191,827 | 296,447 | 10,051,487 | 259,286 |
| Total ........................ do.... | 295,539,312 | 24,571,362 | 314,931,691 | 24,711,446 | 263,020,214 | 22,171,580 | 283,613,122 | 25,467,218 | 344,655,697 | 29,422,371 |
| Vegetables: | | | | | | | | | | |
| Beans and peas ............. bushels.. | 473,975 | 632,073 | 900,219 | 1,110,387 | 854,284 | 1,094,094 | 883,201 | 1,269,812 | 617,355 | 983,401 |
| Onions ........................ do.... | 82,916 | 61,181 | 73,511 | 60,088 | 100,148 | 90,832 | 164,902 | 134,250 | 171,636 | 143,256 |
| Potatoes ...................... do.... | 680,049 | 371,485 | 926,646 | 515,067 | 605,187 | 460,666 | 579,833 | 450,739 | 809,472 | 626,791 |
| Vegetables, canned .............. | ........ | 407,506 | ........ | 408,840 | ........ | 386,039 | ........ | 555,691 | ........ | 603,288 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Other, including pickles and sauces | ............ | 182,805 | ............ | 243,542 | ............ | 350,157 | ............ | 388,908 | ............ | 496,542 |
| Total | ............ | 1,655,050 | ............ | 2,337,924 | ............ | 2,381,788 | ............ | 2,799,400 | ............ | 2,853,278 |
| Vinegar ........ gallons | 123,163 | 16,975 | 93,969 | 11,572 | 108,657 | 12,939 | 107,317 | 13,488 | 115,372 | 12,583 |
| Wines: | | | | | | | | | | |
| Bottled ........ dozen bottles | 17,147 | 69,460 | 16,794 | 69,444 | 9,672 | 46,721 | 10,973 | 52,015 | 9,854 | 49,927 |
| Unbottled ........ gallons | 1.339,090 | 581,827 | 1,389,375 | 629,270 | 1,623,103 | 682,028 | 1,498,078 | 624,315 | 1,408,859 | 575,665 |
| Total | ............ | 651,287 | ............ | 698,714 | ............ | 728,749 | ............ | 676,330 | ............ | 625,592 |
| Yeast | ............ | 45,077 | ............ | 42,849 | ............ | 41,770 | ............ | 36,061 | ............ | 8,086 |
| Total vegetable matter | ............ | 391,133,452 | ............ | 501,432,972 | ............ | 641,210,893 | ............ | 574,433,983 | ............ | 610,851,940 |
| Total agricultural exports | ............ | 574,398,264 | ............ | 689,755,193 | ............ | 859,018,946 | ............ | 792,811,733 | ............ | 844,616,530 |

[1] Not stated.

## AVERAGE PRICES FOR IMPORTS AND EXPORTS.

[From Section of Foreign Markets.]

*Average import price of agricultural products imported into the United States during each of the five fiscal years 1896–1900.*

[The import prices of merchandise here given represent "the actual market value or wholesale price of such merchandise as bought and sold in usual wholesale quantities, at the time of exportation to the United States, in the principal markets of the country from whence imported, and in the condition in which such merchandise is there bought and sold for exportation to the United States, or consigned to the United States for sale, including the value of all cartons, cases, crates, boxes, sacks, and coverings of any kind, and all other costs, charges, and expenses incident to placing the merchandise in condition, packed ready for shipment to the United States." (Act of June 10, 1890.) The export prices are the actual market values in the port of shipment.]

| Articles imported. | Years ended June 30— | | | | | Annual average— | |
|---|---|---|---|---|---|---|---|
| | 1896. | 1897. | 1898. | 1899. | 1900. | 1891–1895. | 1896–1900. |
| ANIMAL MATTER. | | | | | | | |
| Cattle, free of duty ........... head.. | $20.56 | $119.41 | $132.81 | $152.81 | $193.89 | $11.02 | $130.04 |
| Cattle, dutiable ........... do.... | 6.89 | 7.80 | 9.75 | 11.17 | 11.42 | 5.16 | 9.19 |
| Total cattle ........... do.... | 6.93 | 7.87 | 9.99 | 11.62 | 12.47 | 5.80 | 9.51 |
| Horses, free of duty ........... do.... | 196.34 | 138.85 | 181.82 | 277.65 | 278.25 | 368.62 | 224.82 |
| Horses, dutiable ........... do.... | 50.72 | 58.38 | 117.92 | 129.01 | 131.64 | 86.76 | 74.36 |
| Total horses ........... do.... | 66.32 | 66.42 | 134.49 | 181.15 | 192.32 | 146.99 | 102.59 |
| Sheep, free of duty ........... do.... | 10.85 | 13.70 | 14.05 | 19.25 | 19.91 | 19.05 | 14.98 |
| Sheep, dutiable ........... do.... | 2.54 | 2.45 | 2.73 | 3.36 | 3.47 | 3.16 | 2.91 |
| Total sheep ........... do.... | 2.65 | 2.51 | 2.82 | 3.47 | 3.58 | 3.38 | 3.00 |
| Beeswax ........... pound.. | .278 | .249 | .266 | .243 | .241 | .244 | .255 |
| Bristles, crude ........... do.... | 2.23 | .611 | .346 | .579 | .823 | [1].399 | .727 |
| Bristles, sorted, bunched, or prepared ........... pound.. | .912 | .903 | .814 | .788 | .851 | [1].958 | .850 |
| Total bristles ........... do.... | .913 | .903 | .814 | .785 | .851 | .970 | .850 |
| Butter ........... do.... | .164 | .160 | .171 | .167 | .196 | .159 | .173 |
| Cheese ........... do.... | .139 | .135 | .134 | .132 | .131 | .145 | .134 |
| Eggs ........... dozen.. | .094 | .082 | .049 | .095 | .065 | .130 | .085 |
| Silk: | | | | | | | |
| Cocoons ........... pound.. | .405 | ........ | .381 | .169 | .608 | .543 | .413 |
| Raw, or as reeled from the cocoon ........... pound.. | 3.28 | 2.84 | 3.05 | 3.28 | 3.96 | 3.32 | 3.33 |
| Waste ........... do.... | 372 | .285 | .374 | .421 | .427 | .648 | .378 |
| Total silk ........... do.... | 2.86 | 2.37 | 2.66 | 2.89 | 3.47 | 2.91 | 2.89 |
| Wool, class 1, clothing: | | | | | | | |
| In the grease ........... do.... | ........ | .158 | .170 | .150 | ........ | ........ | [2].160 |
| Scoured ........... do.... | ........ | .265 | .280 | .155 | ........ | ........ | [2].266 |
| Total wool, class 1 ........... do.... | .166 | .171 | .175 | .150 | .214 | .176 | .173 |
| Wool, class 2, combing: | | | | | | | |
| In the grease ........... do.... | ........ | .189 | .199 | .272 | ........ | ........ | [2].194 |
| Scoured ........... do.... | ........ | .211 | .210 | .165 | ........ | ........ | [2].211 |
| Total wool, class 2 ........... do.... | .223 | .189 | .199 | .272 | .209 | .217 | .203 |
| Wool, class 3, carpet: | | | | | | | |
| In the grease ........... do.... | ........ | .105 | .096 | .094 | ........ | ........ | [2].099 |
| Scoured ........... do.... | ........ | .118 | .088 | .097 | ........ | ........ | [2].117 |
| Total wool, class 3 ........... do.... | .097 | .105 | .096 | .094 | .091 | .097 | .097 |
| Total wools ........... do.... | .141 | .152 | .126 | .108 | .130 | .127 | .138 |
| Glue ........... do.... | .089 | .096 | .104 | .089 | .096 | .091 | .094 |
| Hides and skins, other than furs: | | | | | | | |
| Goatskins ........... pound.. | .220 | .227 | .243 | .265 | .268 | [1].202 | .249 |
| Hides of cattle ........... do.... | .124 | .106 | .108 | .104 | .118 | [1].088 | [3].111 |
| Other ........... do.... | | | .140 | .148 | .165 | | [3].154 |
| Total hides and skins ........... do.... | .145 | .135 | .151 | .157 | .167 | [1].115 | .153 |
| Honey ........... gallon.. | .383 | .415 | .395 | .409 | .482 | .410 | .424 |
| Sausage, Bologna ........... pound.. | .225 | .233 | ........ | ........ | ........ | ........ | [4].229 |
| Oils, animal, except whale and fish ........... gallon.. | .327 | .158 | .404 | .173 | .180 | .355 | .246 |
| Stearin ........... pound.. | .071 | ........ | ........ | .014 | .018 | [5].091 | [6].023 |
| VEGETABLE MATTER. | | | | | | | |
| Argols, or wine lees ........... pound.. | .096 | .084 | .083 | .082 | .087 | .081 | .087 |
| Barley ........... bushel.. | .379 | .310 | .351 | .486 | .480 | .531 | .355 |
| Corn (maize) ........... do.... | .433 | .329 | .433 | .388 | .783 | .597 | .434 |
| Oats ........... do.... | .274 | .260 | .370 | .385 | .442 | .291 | .328 |
| Oatmeal ........... pound.. | .057 | .021 | .055 | .059 | .057 | .055 | .037 |
| Rye ........... bushel.. | 1.89 | 2.36 | .404 | 2.44 | 1.11 | .729 | .446 |
| Wheat ........... do.... | .657 | .767 | .952 | .752 | .759 | .719 | .782 |
| Wheat flour ........... barrel.. | 4.91 | 4.41 | 4.46 | 4.48 | 5.26 | 5.12 | 4.60 |
| Broom corn ........... ton.. | ........ | ........ | ........ | ........ | 90.37 | ........ | [7]90.37 |
| Chocolate, other than confectionery and sweetened chocolate. pound.. | .173 | .163 | .151 | .187 | .199 | .206 | .173 |

[1] Statistics for 1895 only.
[2] Annual average, 1897–1899.
[3] Annual average, 1898–1900.
[4] Annual average, 1896–1897.
[5] Statistics for 1893 only.
[6] Annual average for the three years 1896, 1899, and 1900.
[7] Statistics for 1900 only.

*Average import price of agricultural products imported into the United States during each of the five fiscal years 1896–1900*—Continued.

| Articles imported. | Years ended June 30— | | | | | Annual average— | |
|---|---|---|---|---|---|---|---|
| | 1896. | 1897. | 1898. | 1899. | 1900. | 1891–1895. | 1896–1900. |
| VEGETABLE MATTER—continued. | | | | | | | |
| Cider ........ gallon.. | ........ | ........ | ........ | ........ | $0.864 | [1] $0.270 | [2] $0.864 |
| Cocoa, crude, and leaves and shells of ........ pound.. | $0.103 | $0.095 | $0.136 | $0.143 | .136 | .133 | .124 |
| Cocoa, prepared or manufactured, pound ........ | .330 | .297 | .357 | .319 | .310 | .360 | .319 |
| Total cocoa ........ pound.. | .114 | .105 | .143 | .147 | .140 | .149 | .131 |
| Coffee ........ do.... | .146 | .111 | .075 | .066 | .067 | .168 | .089 |
| Chicory root, raw, unground ..do.... | .013 | .014 | .016 | .015 | .015 | [3] .019 | .014 |
| Chicory root, roasted, ground, or otherwise prepared ........ pound.. | .033 | .035 | ........ | .033 | .034 | [3] .036 | [4] .034 |
| Total chicory root ........ do.... | .014 | .014 | ........ | .027 | .019 | .023 | [4] .014 |
| Coffee substitutes, n. e. s. ........ do.... | .038 | .037 | .034 | .037 | .039 | .039 | .037 |
| Total coffee substitutes ........ do.... | .017 | .017 | ........ | .033 | .028 | .026 | [4] .018 |
| Cotton ........ do.... | .119 | .113 | .095 | .100 | .118 | .109 | .110 |
| Flax ........ ton.. | 230.36 | 206.53 | 215.88 | 201.81 | 236.30 | 274.36 | 218.05 |
| Hemp ........ do.... | 126.57 | 124.97 | 139.49 | 121.06 | 132.43 | [3] 133.93 | 128.24 |
| Istle, or Tampico fiber ........ do.... | 58.78 | 53.20 | 50.84 | 64.31 | 82.65 | [3] 56.00 | 62.18 |
| Jute and jute butts ........ do.... | 22.49 | 23.93 | 22.65 | 27.61 | 38.53 | 29.20 | 27.29 |
| Manila hemp ........ do.... | 76.30 | 73.68 | 64.44 | 116.77 | 168.27 | [3] 122.00 | 98.65 |
| Sisal grass ........ do.... | 65.47 | 60.61 | 74.58 | 128.12 | 153.17 | [3] 89.05 | 100.17 |
| Fibers, vegetable, n. e. s. ........ do.... | 41.13 | 66.32 | 62.22 | 68.74 | 81.36 | [3] 89.91 | 65.93 |
| Fruit juices, n. e. s.: | | | | | | | |
| Prune juice or prune wine, gallon ........ | .830 | .701 | .890 | .776 | .815 | .893 | .798 |
| Other, including cherry juice, gallon ........ | ........ | ........ | .489 | .517 | .617 | ........ | [5] .540 |
| Total fruit juices ........ gallon.. | ........ | ........ | .621 | .631 | .707 | ........ | [5] .655 |
| Currants ........ pound.. | .017 | .020 | .033 | .026 | .025 | [3] .025 | .024 |
| Dates ........ do.... | .020 | .024 | .027 | .025 | .021 | [3] .029 | .023 |
| Figs ........ do.... | .054 | .060 | .053 | .049 | .058 | .057 | .055 |
| Lemons ........ do.... | ........ | ........ | ........ | .019 | .023 | ........ | [6] .021 |
| Oranges ........ do.... | ........ | ........ | ........ | .013 | .016 | ........ | [6] .014 |
| Plums and prunes ........ do.... | .142 | .103 | .130 | .106 | .108 | .048 | .115 |
| Raisins ........ do.... | .043 | .045 | .058 | .057 | .052 | .046 | .049 |
| Almonds ........ do.... | .098 | .091 | .115 | .123 | .150 | .123 | .113 |
| Ginger, preserved or pickled ..do.... | ........ | ........ | ........ | .044 | .042 | ........ | [6] .042 |
| Hay ........ ton.. | 9.16 | 8.59 | 8.92 | 5.81 | 7.09 | 8.14 | 8.43 |
| Hops ........ pound.. | .217 | .209 | .273 | .449 | .276 | .368 | .264 |
| Indigo ........ do.... | .501 | .482 | .586 | .543 | .527 | .724 | .526 |
| Malt, barley ........ bushel.. | .856 | .847 | .925 | .892 | .938 | .691 | .881 |
| Malt liquors, bottled ........ gallon.. | .970 | .978 | .948 | .999 | .998 | .950 | .980 |
| Malt liquors, unbottled ........ do.... | .293 | .279 | .285 | .296 | .291 | .324 | .289 |
| Total malt liquors ........ do.... | .507 | .526 | .479 | .523 | .522 | .553 | .512 |
| Oil cake ........ pound.. | .006 | .007 | .004 | .005 | .007 | .009 | .006 |
| Olive oil, salad ........ gallon.. | 1.17 | 1.22 | 1.25 | 1.17 | 1.21 | 1.24 | 1.20 |
| Opium, crude or unmanufactured, pound ........ | 1.87 | 2.04 | 2.14 | 2.38 | 2.06 | 2.13 | 2.09 |
| Opium, prepared ........ pound.. | 7.44 | 7.21 | 6.51 | 6.67 | 7.48 | 6.86 | 7.09 |
| Total opium ........ do.... | 3.06 | 2.70 | 4.10 | 3.22 | 3.19 | 2.74 | 3.05 |
| Rice ........ do.... | .016 | .019 | .022 | .020 | .020 | .020 | .020 |
| Rice flour, rice meal, and broken rice ........ pound.. | .013 | .015 | .016 | .015 | .016 | .016 | .015 |
| Total rice, rice meal, etc ........ do.... | .015 | .018 | .020 | .019 | .020 | .019 | .018 |
| Linseed, or flaxseed ........ bushel.. | 1.08 | 1.03 | 1.11 | 1.07 | 1.40 | 1.11 | 1.10 |
| Spices, unground: | | | | | | | |
| Nutmegs ........ pound.. | .320 | .270 | .273 | .241 | .221 | .416 | .263 |
| Pepper, black or white ...do.... | .039 | .047 | .065 | .088 | .098 | .062 | .065 |
| Other (free of duty) ......do.... | .052 | .053 | .065 | .072 | .070 | .063 | .062 |
| Spices, ground (and other dutiable), pound ........ | .113 | .111 | .100 | .099 | .086 | .135 | .100 |
| Total spices ........ pound.. | .060 | .064 | .076 | .090 | .088 | .081 | .075 |
| Spirits, distilled: | | | | | | | |
| Of domestic manufacture, returned ........ proof gallon.. | .913 | .903 | .860 | .836 | .918 | 1.05 | .885 |
| Brandy ........ do.... | 2.66 | 2.70 | 2.87 | 2.85 | 2.85 | 2.68 | 2.77 |
| Other ........ do.... | 1.16 | 1.20 | 1.30 | 1.37 | 1.47 | 1.01 | 1.30 |
| Total distilled spirits ........ do.... | 1.21 | 1.27 | 1.21 | 1.29 | 1.45 | 1.24 | 1.29 |
| Starch ........ pound.. | .018 | .018 | .017 | .016 | .019 | .022 | .018 |
| Straw ........ ton.. | 3.95 | 3.38 | 3.08 | 2.20 | 2.87 | 3.42 | 3.34 |
| Molasses ........ gallon.. | .157 | .158 | .151 | .136 | .127 | .116 | .143 |
| Sugar not above No. 16 Dutch standard: | | | | | | | |
| Beet ........ pound.. | .023 | .018 | .019 | .021 | .021 | .028 | .020 |
| Cane and other ........ do.... | .022 | .021 | .023 | .024 | .026 | .028 | .023 |

[1] Statistics for 1893 only.
[2] Statistics for 1900 only.
[3] Annual average, 1892–1895.
[4] Annual average for the four years 1896, 1897, 1899, and 1900.
[5] Annual average for 1898–1900.
[6] Annual average, 1899–1900.

*Average import price of agricultural products imported into the United States during each of the five fiscal years 1896–1900*—Continued.

| Articles imported. | Years ended June 30— 1896. | 1897. | 1898. | 1899. | 1900. | Annual average— 1891–1895. | 1896–1900. |
|---|---|---|---|---|---|---|---|
| VEGETABLE MATTER—continued. | | | | | | | |
| Sugar above No. 16 Dutch standard.....pound.. | $0.029 | $0.025 | $0.024 | $0.027 | $0.034 | $0.035 | $0.026 |
| Total sugar.....do.... | .023 | .020 | .022 | .024 | .025 | .028 | .023 |
| Tea.....do.... | .135 | .131 | .140 | .131 | .124 | .153 | .132 |
| Tobacco: | | | | | | | |
| Suitable for cigar wrappers, pound..... | 1.07 | .935 | .981 | 1.05 | .921 | [1] 1.05 | .987 |
| Other leaf, etc. (including stems).....pound.. | .394 | .506 | .551 | .561 | .581 | [1] .396 | .488 |
| Total tobacco.....do.... | .501 | .694 | .715 | .705 | .678 | .535 | .625 |
| Vanilla beans.....do.... | 4.30 | 5.36 | 4.37 | 4.54 | 4.72 | 3.52 | 4.66 |
| Beans and peas.....bushel.. | 1.07 | 1.01 | .912 | .899 | 1.09 | 1.06 | 1.04 |
| Cabbages.....number.. | .044 | .055 | ..... | ..... | ..... | ..... | [2] .048 |
| Onions.....bushel.. | ..... | 1.12 | .878 | .647 | .655 | ..... | [3] .808 |
| Potatoes.....do.... | .728 | .591 | .404 | .555 | .945 | .486 | .521 |
| Vinegar.....gallon.. | .303 | .270 | .261 | .252 | .251 | .270 | .265 |
| Champagne and other sparkling wines.....dozen bottles.. | 14.73 | 14.64 | 14.58 | 13.98 | 13.27 | 14.52 | 14.18 |
| Still wines: | | | | | | | |
| Bottled.....do.... | 4.86 | 4.77 | 4.88 | 4.90 | 4.94 | 5.02 | 4.87 |
| Unbottled.....gallon.. | .688 | .680 | .721 | .698 | .689 | .700 | .693 |

[1] Annual average, 1892–1895. [2] Annual average, 1896–1897. [3] Annual average, 1897–1900.

*Average export price of domestic agricultural products exported from the United States during each of the five fiscal years 1896–1900.*

| Articles exported. | Years ended June 30— 1896. | 1897. | 1898. | 1899. | 1900. | Annual average— 1891–1895. | 1896–1900. |
|---|---|---|---|---|---|---|---|
| ANIMAL MATTER. | | | | | | | |
| Cattle.....head.. | $92.79 | $92.70 | $86.12 | $78.35 | $77.11 | $89.07 | $85.35 |
| Hogs.....do.... | 10.80 | 10.30 | 7.67 | 6.88 | 7.71 | 12.19 | 8.46 |
| Horses.....do.... | 140.52 | 120.64 | 120.75 | 118.93 | 117.62 | 190.40 | 121.66 |
| Mules.....do.... | 68.63 | 72.97 | 82.09 | 76.52 | 90.38 | 111.48 | 84.52 |
| Sheep.....do.... | 6.26 | 6.27 | 6.08 | 5.96 | 5.83 | 5.87 | 6.15 |
| Beeswax.....pound.. | .296 | .289 | .277 | .275 | .288 | .265 | .286 |
| Butter.....do.... | .152 | .143 | .150 | .161 | .172 | .165 | .154 |
| Cheese.....do.... | .084 | .091 | .086 | .087 | .102 | .093 | .090 |
| Eggs.....dozen.. | .147 | .139 | .163 | .174 | .166 | .182 | .165 |
| Feathers, other than ostrich.pound.. | .166 | .099 | ..... | ..... | ..... | [1] .150 | [2] .132 |
| Glue.....do.... | .095 | .095 | .090 | .094 | .096 | .104 | .094 |
| Hides and skins, other than furs, pound..... | .098 | .077 | .088 | .092 | .107 | [3] .064 | .090 |
| Beef, canned.....pound.. | .088 | .086 | .088 | .091 | .094 | .088 | .090 |
| Beef, fresh.....do.... | .084 | .078 | .084 | .083 | .090 | .084 | .084 |
| Beef, salted or pickled.....do.... | .056 | .052 | .053 | .054 | .057 | .056 | .055 |
| Beef, other cured.....do.... | .115 | .089 | .094 | .092 | .085 | .091 | .092 |
| Tallow.....do.... | .044 | .037 | .038 | .041 | .049 | .050 | .042 |
| Bacon.....do.... | .079 | .068 | .071 | .074 | .076 | .083 | .073 |
| Hams.....do.... | .098 | .097 | .095 | .092 | .104 | .107 | .097 |
| Pork, canned.....do.... | ..... | ..... | ..... | ..... | .077 | ..... | [4] .077 |
| Pork, fresh.....do.... | .059 | .073 | .067 | .066 | .074 | .078 | .069 |
| Pork, salted or pickled.....do.... | .057 | .049 | .056 | .058 | .062 | .068 | .057 |
| Lard.....do.... | .066 | .051 | .056 | .059 | .063 | .080 | .059 |
| Mutton.....do.... | .075 | .078 | .085 | .078 | .083 | .081 | .080 |
| Oleo oil.....do.... | .078 | .059 | .060 | .064 | .072 | .097 | .066 |
| Oleomargarin (imitation butter), pound..... | .097 | .097 | .089 | .092 | .098 | .111 | .095 |
| Animal oils, n. e. s.: | | | | | | | |
| Lard oil.....gallon.. | .511 | .437 | .395 | .450 | .457 | .578 | .450 |
| Other, except whale and fish, gallon..... | .504 | .425 | .409 | .387 | .453 | .559 | .437 |
| Total animal oils, n. e. s.....gallon.. | .510 | .435 | .397 | .440 | .455 | .573 | .448 |
| Silk waste.....pound.. | .304 | .244 | .123 | .125 | .189 | .364 | .184 |
| Stearin.....do.... | .051 | .051 | .047 | .048 | ..... | .049 | [5] .048 |
| Wool.....do.... | .123 | .118 | .149 | .141 | .176 | .123 | .131 |
| VEGETABLE MATTER. | | | | | | | |
| Barley.....bushel.. | .404 | .382 | .493 | .607 | .474 | .518 | .445 |
| Bran, middlings, and mill feed.ton.. | ..... | ..... | 14.58 | 15.65 | 15.84 | ..... | [6] 15.48 |

[1] Annual average for the two years 1893 and 1895.
[2] Annual average, 1896–1897.
[3] Statistics for 1895 only.
[4] Statistics for 1900 only.
[5] Annual average, 1896–1899.
[6] Annual average, 1898–1900.

*Average export price of domestic agricultural products exported from the United States during each of the five fiscal years 1896–1900*—Continued.

| Articles exported. | Years ended June 30— | | | | | Annual average— | |
|---|---|---|---|---|---|---|---|
| | 1896. | 1897. | 1898. | 1899. | 1900. | 1891–1895. | 1896–1900. |
| VEGETABLE MATTER—continued. | | | | | | | |
| Bread and biscuit...........pound.. | $0.045 | $0.046 | $0.049 | $0.049 | $0.051 | $0.050 | $0.048 |
| Buckwheat.................bushel.. | ........ | .405 | .430 | .552 | .597 | ........ | [1].473 |
| Corn (maize) ................do.... | .378 | .306 | .355 | .396 | .407 | .525 | .369 |
| Corn meal...................barrel.. | 2.36 | 1.90 | 2.13 | 2.24 | 2.28 | 2.93 | 2.19 |
| Oats ........................bushel.. | .269 | .249 | .298 | .323 | .302 | .389 | .292 |
| Oatmeal ....................pound.. | .024 | .023 | .021 | .022 | .023 | .027 | .022 |
| Rye.........................bushel.. | .450 | .428 | .568 | .585 | .612 | .907 | .541 |
| Rye flour....................barrel.. | 2.96 | 2.87 | 3.46 | 3.11 | 3.38 | 3.92 | 3.17 |
| Wheat.......................bushel.. | .655 | .753 | .983 | .748 | .718 | .829 | .798 |
| Wheat flour.................barrel.. | 3.56 | 3.84 | 4.51 | 3.95 | 3.62 | 4.34 | 3.89 |
| Cider .......................gallon.. | .128 | .122 | .129 | .131 | .133 | .141 | .128 |
| Cotton, sea-island...........pound.. | .199 | .189 | .177 | .167 | .164 | .198 | .180 |
| Cotton, upland and other.....do.... | .080 | .074 | .059 | .055 | .077 | .080 | .068 |
| Total cotton in bales..........do.... | .081 | .074 | .060 | .056 | .078 | .081 | .068 |
| Waste cotton....................do.... | ........ | ........ | .041 | .037 | .045 | ........ | [2].042 |
| Total cotton ...................do.... | .081 | .074 | .060 | .055 | .078 | .081 | .068 |
| Apples, dried...................do.... | .050 | .044 | .061 | .065 | .064 | .055 | .057 |
| Apples, green or ripe ........barrel.. | 2.58 | 1.58 | 2.78 | 3.18 | 2.74 | 2.60 | 2.26 |
| Prunes.......................pound.. | ........ | ........ | .064 | .068 | .064 | ........ | [2].064 |
| Raisins .........................do.... | ........ | ........ | .054 | .052 | .058 | ........ | [2].054 |
| Ginseng.........................do.... | 3.86 | 4.68 | 3.67 | 3.99 | 5.18 | 3.36 | 4.25 |
| Glucose and grape sugar......do.... | .016 | .014 | .015 | .016 | .016 | .021 | .015 |
| Hay ............................ton.. | 14.80 | 13.71 | 14.07 | 13.23 | 13.65 | 15.98 | 13.88 |
| Hops .........................pound.. | .088 | .114 | .154 | .171 | .135 | .194 | .136 |
| Lard substitutes, n. e. s. (cottolene, lardine, etc.)[3] ............pound.. | .060 | .053 | .052 | .054 | .057 | [4].078 | [5].057 |
| Malt..........................bushel.. | .635 | .612 | .707 | .715 | .725 | .777 | .687 |
| Malt liquors, bottled.dozen bottles.. | 1.20 | 1.16 | 1.22 | 1.21 | 1.23 | 1.37 | 1.21 |
| Malt liquors, unbottled .....gallon.. | .240 | .223 | .226 | .257 | .255 | .264 | .244 |
| Oil cake and oil-cake meal: | | | | | | | |
| Corn .....................pound.. | ........ | ........ | .009 | .009 | .010 | ........ | [2].010 |
| Cotton-seed ..................do.... | .009 | .009 | .009 | .009 | .010 | [6].009 | .009 |
| Flaxseed, or linseed ......do.... | .011 | .009 | .010 | .011 | .011 | [6].012 | .011 |
| Total oil cake and oil-cake meal, pound | .010 | .009 | .009 | .009 | .010 | .011 | .010 |
| Corn oil.......................gallon.. | ........ | ........ | .218 | .239 | .308 | ........ | [2].265 |
| Cotton-seed oil..................do.... | .282 | .254 | .252 | .239 | .301 | .365 | .264 |
| Linseed oil......................do.... | .495 | .384 | .427 | .446 | .523 | .541 | .451 |
| Peppermint oil .............pound.. | 2.05 | 1.58 | 1.24 | 1.01 | 1.01 | 2.58 | 1.37 |
| Rice.............................do.... | .010 | .038 | .043 | .045 | .039 | [7].038 | .037 |
| Rice bran, meal, and polish ..do.... | .006 | .006 | .006 | .006 | .006 | [7].009 | .006 |
| Total rice, rice meal, etc......do.... | .006 | .009 | .010 | .008 | .016 | .011 | .012 |
| Root beer ............dozen quarts.. | ........ | ........ | ........ | ........ | 1.36 | ........ | [5]1.36 |
| Cotton seed ..................pound.. | .007 | .006 | .006 | .006 | .007 | .008 | .006 |
| Flaxseed, or linseed........bushel.. | .910 | .820 | .899 | .995 | 1.27 | 1.14 | .983 |
| Clover seed .................pound.. | .079 | .077 | .061 | .063 | .074 | .093 | .069 |
| Timothy seed ...................do.... | .044 | .034 | .031 | .031 | .034 | .048 | .034 |
| Alcohol, including cologne spirits, proof gallon ........................ | .257 | .336 | .286 | .289 | .333 | .332 | .292 |
| Brandy ...............proof gallon.. | .978 | 1.07 | 1.59 | 1.40 | 1.04 | .816 | 1.11 |
| Rum ............................do.... | 1.36 | 1.36 | 1.39 | 1.38 | 1.35 | 1.20 | 1.37 |
| Bourbon whisky ...............do.... | 1.34 | .742 | .841 | 1.19 | .886 | .939 | .904 |
| Rye whisky......................do.... | 1.70 | 1.80 | 1.78 | 1.57 | 1.32 | 1.16 | 1.53 |
| Distilled spirits, n. e. s..........do.... | .450 | .451 | .818 | 1.25 | 1.34 | .468 | .501 |
| Total distilled spirits .........do.... | .967 | .834 | .637 | .773 | 1.03 | .875 | .828 |
| Starch ........................pound.. | .028 | .021 | .019 | .021 | .021 | .032 | .021 |
| Molasses .....................gallon.. | ........ | ........ | .070 | .078 | .112 | ........ | [2].086 |
| Sirup.............................do.... | ........ | ........ | .105 | .146 | .151 | ........ | [2].137 |
| Total molasses and sirup......do.... | .106 | .088 | .093 | .121 | .141 | .116 | .114 |
| Sugar, brown.................pound.. | .035 | .032 | .038 | .035 | .035 | .037 | .034 |
| Sugar, refined ...................do.... | .049 | .047 | .050 | .045 | .045 | .053 | .047 |
| Total sugar .....................do.... | .049 | .045 | .049 | .045 | .045 | .053 | .046 |
| Sugar meal .....................do.... | .017 | ........ | ........ | ........ | ........ | ........ | [8].017 |
| Tobacco, leaf.....................do.... | .085 | .080 | .087 | .092 | .087 | .087 | .086 |
| Tobacco stems and trimmings.do.... | .021 | .022 | .023 | .026 | .026 | .035 | .024 |
| Total tobacco ...................do.... | .083 | .078 | .084 | .090 | .085 | .084 | .084 |
| Beans and peas..............bushel.. | 1.33 | 1.23 | 1.28 | 1.44 | 1.59 | 1.72 | 1.36 |
| Onions ...........................do.... | .738 | .817 | .907 | .814 | .835 | 1.06 | .825 |
| Potatoes..........................do.... | .546 | .556 | .761 | .777 | .774 | .785 | .673 |
| Vinegar.........................gallon.. | .138 | .123 | .119 | .126 | .109 | .146 | .123 |
| Wines, bottled .......dozen bottles.. | 4.05 | 4.14 | 4.83 | 4.74 | 5.07 | 4.48 | 4.46 |
| Wines, unbottled ..........gallon.. | .434 | .453 | .420 | .417 | .409 | .518 | .426 |

[1] Annual average, 1897–1900.
[2] Annual average, 1898–1900.
[3] In 1900, including stearin.
[4] Annual average, 1893–1895.
[5] Statistics for 1900 only.
[6] Statistics for 1895 only.
[7] Annual average for the four years 1891, 1893, 1894, and 1895.
[8] Statistics for 1896 only.

## SOURCES OF SUGAR IMPORTS.

[From Section of Foreign Markets.]

*Quantity and value of sugar imported into the United States from the principal countries of supply during each fiscal year from 1896 to 1900, inclusive.*

QUANTITIES.

| Countries from which imported. | Years ended June 30— | | | | | Annual average, 1896–1900. | |
|---|---|---|---|---|---|---|---|
| | 1896. | 1897. | 1898. | 1899. | 1900. | | |
| | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* | *Pounds.* | *Per ct.* |
| Dutch East Indies | 567,670,780 | 634,171,629 | 621,731,462 | 986,438,330 | 1,162,202,854 | 794,443,011 | 20.37 |
| Germany | 525,991,657 | 1,604,233,071 | 175,275,440 | 667,127,773 | 590,984,996 | 712,722,587 | 18.27 |
| Cuba | 1,093,171,312 | 577,790,173 | 440,225,111 | 663,543,657 | 705,456,230 | 696,037,297 | 17.84 |
| Hawaii | 352,175,269 | 431,217,116 | 499,776,895 | 462,423,600 | 504,713,105 | 450,061,198 | 11.54 |
| British West Indies | 217,421,118 | 322,103,866 | 231,401,746 | 267,565,738 | 200,479,351 | 247,794,364 | 6.35 |
| British Guiana | 146,433,256 | 175,639,179 | 139,145,529 | 138,152,464 | 149,715,600 | 149,817,206 | 3.84 |
| Brazil | 191,457,878 | 140,773,692 | 139,426,285 | 41,222,162 | 89,684,600 | 120,512,924 | 3.09 |
| Santo Domingo | 116,972,841 | 131,279,582 | 94,336,444 | 112,213,037 | 122,206,692 | 115,401,719 | 2.96 |
| Egypt | 100,335,317 | 124,055,211 | 52,354,144 | 141,940,690 | 74,015,702 | 98,540,213 | 2.53 |
| Porto Rico | 81,582,810 | 86,607,317 | 98,452,421 | 107,208,014 | 72,558,181 | 89,281,749 | 2.29 |
| Philippine Islands | 145,075,344 | 72,463,577 | 29,489,600 | 51,625,280 | 49,490,542 | 69,628,869 | 1.78 |
| Austria-Hungary | 40,703,929 | 105,138,128 | 2,788,767 | 69,397,343 | 96,130,457 | 62,831,724 | 1.61 |
| Belgium | 72,721,186 | 130,423,987 | 1,366,370 | 30,000 | 15,198,903 | 43,948,089 | 1.13 |
| United Kingdom | 56,992,162 | 68,250,019 | 21,106,706 | 16,685,790 | 9,375,569 | 34,482,050 | .88 |
| Netherlands | 40,965,863 | 82,248,664 | 38,659,827 | 6,894,728 | 153,860 | 33,784,589 | .87 |
| British Africa | 26,564,115 | 25,895,460 | 12,081,142 | 55,075,128 | 36,502,673 | 31,223,704 | .80 |
| Peru | ............ | 2,863,350 | 8,544,857 | 50,080,303 | 75,155,975 | 27,328,897 | .70 |
| France | 34,810,370 | 92,169,241 | 17,781 | 66,007 | 9,819 | 25,414,643 | .65 |
| Dutch Guiana | 12,299,609 | 18,043,833 | 25,636,341 | 38,124,370 | 13,265,520 | 21,473,935 | .55 |
| Danish West Indies | 12,202,619 | 16,999,347 | 14,832,991 | 22,711,543 | 21,664,980 | 17,682,296 | .45 |
| Chinese Empire | 31,827,859 | 11,437,760 | 7,161,664 | 10,758,164 | 4,606,743 | 13,158,438 | .34 |
| Argentina | 6,341,221 | 46,940,759 | 12,428,502 | ............ | ............ | 13,142,096 | .34 |
| British East Indies | 2,565,592 | 11,173,293 | 9,381,265 | 29,599,283 | 9,840,433 | 12,511,973 | .32 |
| Hongkong | 12,046,973 | 3,243,630 | 4,183,246 | 5,084,695 | 2,419,268 | 5,395,562 | .14 |
| Russia, European | ............ | 815,702 | 242,575 | 14,800,295 | 866,788 | 3,345,072 | .09 |
| Mexico | 4,006,707 | 1,412,255 | 3,059,018 | 3,088,609 | 1,892,029 | 2,691,723 | .07 |
| Guatemala | ............ | ............ | 4,921,135 | 4,477,566 | 3,126,580 | 2,505,056 | .06 |
| Dutch West Indies | 1,972,828 | 86,652 | 277,260 | 5,085,441 | 3,378,637 | 2,160,164 | .05 |
| Canada | 1,304,887 | 1,098,330 | 717,532 | 2,020,001 | 878,778 | 1,203,906 | .03 |
| Turkey, Asiatic | ............ | ............ | ............ | 3,361,397 | 58 | 672,291 | .02 |
| Salvador | ............ | ............ | ............ | 2,471,012 | 61,700 | 506,542 | .01 |
| Other countries | 725,055 | 330,910 | 898,795 | 978,149 | 2,049,907 | 996,561 | .03 |
| Total | 3,896,338,557 | 4,918,905,733 | 2,689,920,851 | 3,980,250,569 | 4,018,086,530 | 3,900,700,448 | 100.00 |

VALUES.

| Countries from which imported. | 1896. | 1897. | 1898. | 1899. | 1900. | Annual average, 1896–1900. | |
|---|---|---|---|---|---|---|---|
| | *Dollars.* | *Dollars.* | *Dollars.* | *Dollars.* | *Dollars.* | *Dollars.* | *Per ct.* |
| Cuba | 24,102,835 | 11,982,473 | 9,828,607 | 16,412,088 | 18,243,644 | 16,113,930 | 18.15 |
| Dutch East Indies | 11,388,487 | 13,090,323 | 11,250,181 | 19,817,646 | 24,170,081 | 15,943,344 | 17.95 |
| Hawaii | 11,336,796 | 13,165,084 | 16,660,412 | 17,292,723 | 20,392,150 | 15,769,434 | 17.76 |
| Germany | 12,528,755 | 29,844,019 | 3,520,796 | 14,095,417 | 12,346,734 | 14,467,144 | 16.29 |
| British West Indies | 4,700,527 | 5,893,877 | 4,552,454 | 6,049,479 | 4,603,409 | 5,159,950 | 5.81 |
| British Guiana | 3,414,368 | 3,657,025 | 3,045,666 | 3,461,889 | 3,779,398 | 3,471,670 | 3.91 |
| Santo Domingo | 2,459,302 | 2,059,169 | 2,030,239 | 2,659,456 | 3,365,061 | 2,514,645 | 2.83 |
| Egypt | 2,657,425 | 2,616,423 | 1,230,071 | 3,570,343 | 1,843,077 | 2,383,467 | 2.68 |
| Brazil | 3,776,486 | 2,136,989 | 2,317,990 | 810,276 | 1,693,588 | 2,147,066 | 2.42 |
| Porto Rico | 1,707,318 | 1,577,911 | 1,913,742 | 2,495,849 | 2,449,616 | 2,028,887 | 2.28 |
| Austria-Hungary | 958,402 | 1,957,027 | 67,831 | 1,485,037 | 2,132,790 | 1,320,217 | 1.49 |
| Philippine Islands | 2,270,902 | 1,199,202 | 381,279 | 969,323 | 925,335 | 1,149,208 | 1.29 |
| Belgium | 1,771,980 | 2,311,309 | 31,909 | 788 | 353,699 | 893,937 | 1.01 |
| Netherlands | 1,182,605 | 1,916,933 | 957,908 | 176,013 | 4,151 | 847,522 | .95 |
| United Kingdom | 1,402,694 | 1,452,004 | 504,714 | 434,237 | 228,447 | 804,418 | .91 |
| Dutch Guiana | 289,243 | 380,959 | 585,326 | 953,047 | 375,633 | 516,842 | .58 |
| Peru | ............ | 56,969 | 148,599 | 921,430 | 1,444,784 | 514,356 | .58 |
| British Africa | 461,054 | 417,850 | 131,469 | 835,950 | 576,585 | 484,582 | .55 |
| France | 859,359 | 1,421,317 | 480 | 2,506 | 563 | 456,845 | .51 |
| Danish West Indies | 261,728 | 316,781 | 312,446 | 556,562 | 544,985 | 398,501 | .45 |
| Chinese Empire | 920,301 | 313,803 | 176,751 | 296,574 | 125,986 | 366,684 | .41 |
| Argentina | 159,108 | 917,457 | 260,957 | ............ | ............ | 267,505 | .30 |
| British East Indies | 32,839 | 174,531 | 134,838 | 566,297 | 203,610 | 222,423 | .25 |
| Hongkong | 353,610 | 87,465 | 107,295 | 141,767 | 69,697 | 151,956 | .17 |
| Canada | 92,692 | 74,191 | 32,589 | 139,023 | 94,809 | 86,660 | .10 |
| Guatemala | ............ | ............ | 212,637 | 118,262 | 70,416 | 80,263 | .09 |
| Russia, European | ............ | 14,927 | 5,736 | 340,815 | 22,993 | 76,894 | .09 |
| Dutch West Indies | 48,974 | 1,761 | 4,811 | 136,893 | 98,014 | 58,091 | .07 |
| Mexico | 63,572 | 19,111 | 48,682 | 52,995 | 41,082 | 45,088 | .05 |
| Turkey, Asiatic | ............ | ............ | ............ | 85,226 | 3 | 17,046 | .02 |
| Salvador | ............ | ............ | ............ | 63,459 | 1,521 | 12,996 | .01 |
| Other countries | 18,411 | 9,291 | 16,334 | 22,750 | 49,113 | 23,178 | .04 |
| Total | 89,219,773 | 99,066,181 | 60,472,749 | 94,964,120 | 100,250,974 | 88,794,759 | 100.00 |

# INDEX.

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