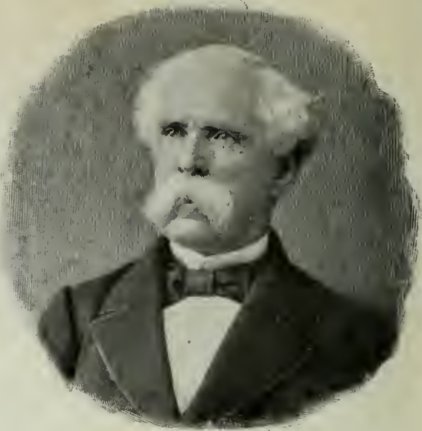
ISAAC NEWTON.
(Commissioner of Agriculture, 1862-1867.)



HORACE CAPRON.
(Commissioner of Agriculture, 1867-1871.)

JEREMIAH M. RUSK.
(Secretary of Agriculture, 1889-1893.)

FREDERICK WATTS.
(Commissioner of Agriculture, 1871-1877.)

GEORGE B. LORING.
(Commissioner of Agriculture, 1881-1885.)

HEADS (DECEASED) OF THE DEPARTMENT OF AGRICULTURE.

YEARBOOK

OF THE

UNITED STATES

DEPARTMENT OF AGRICULTURE.

1899.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1900.

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

AN ACT providing for the public printing and binding and 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 the Annual Report of the Secretary of Agriculture for 1898 there occurred the following reference to the Yearbook for 1899:

> * * * For 1899 I am considering the propriety of making a special effort to prepare a publication which shall contain a résumé of the achievements in the United States in every branch of science as related to agriculture during the nineteenth century, for distribution at the Paris Exposition.

The plan thus suggested was not lost sight of, and in the circular letter instructing the chiefs of Bureaus, Divisions, and Offices as to the matter to be supplied the Secretary expressed his earnest desire that the idea presented in his Annual Report for 1898, quoted above, should be carried out as far as possible in the preparation of the papers for the present volume. He said:

> I desire that the Yearbook for 1899, the distribution of which will occur during the last year of this century, shall present to the reader a picture of the development of agriculture in the United States during the nineteenth century and of its condition at the present time, and show in a special manner the effect upon agricultural industry of the application of science in its several branches to the service of agriculture. Every Bureau and Division in the Department charged with scientific work should therefore contribute one or two articles reviewing the progress made in the application to agriculture of the particular science with which it is concerned.

In the execution of this design it has been necessary to somewhat limit the number of papers, owing to the space desired for the proper treatment of the various subjects. In addition to the Annual Report of the Secretary, which, in accordance with the law providing for the publication of the Yearbook, has the first place in the volume, there are but twenty-six papers. A glance at the list of titles on page 5 will show that in the main the plan laid down by the Secretary has been carried out. A wide latitude, however, has been allowed to each writer in the presentation of his subject, as each one was dealing with what has been practically his life work. The result is, it is believed, to present for the first time within the covers of a single volume a fairly comprehensive review of the progress and development of a century in almost every branch of scientific inquiry having a direct practical bearing upon agriculture.

It is gratifying to record in this connection that Congress has made provision for an extra distribution of this number of the Yearbook by providing a special edition to be available for foreign distribution during the time of the Paris Exposition of 1900—an edition which will be literally "extra," not only as to number but as to workmanship. So much for the miscellaneous papers from the several chiefs of the Bureaus, Divisions, and Offices. Two papers only are contributed by others than Department officers and employees, that on the "Work of the breeder in improving live stock" and that on the "Development of transportation in the United States." These papers were prepared by two gentlemen each of whom is especially qualified by the experience of a lifetime to treat of the subject assigned to him.

The general character of the Appendix has not been materially changed; such modifications as have been made are in the direction of expansion, with a view to the making of this part of the Yearbook a convenient and full ready-reference book, excluding no information which might be of value to any resident in a rural district. The steps which have already been taken in this direction will be continued in the future.

It should be said in speaking of the Appendix, the character of which precludes the giving of individual credit for the various contributions, that all the Bureaus, Divisions, and Offices of the Department have supplied a share, oftentimes involving a very large amount of work, not infrequently more than is required in the preparation of papers for the main body of the volume. The illustrations include sixty-three plates and numerous text figures.

It is proper to state here that acknowledgments are due to many persons for information kindly supplied by them to the writers of several of the papers comprised in this volume, but the frequency of such aid makes it impossible to particularize, and confines us to this general acknowledgment on behalf of the writers thus favored.

GEO. WM. HILL,
Editor.

WASHINGTON, D. C., *April 20, 1900.*

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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 ending June 30, 1899. This report touches upon the work regularly carried on by the several Bureaus, Divisions, and Offices, and also indicates the new lines of scientific inquiry inaugurated by the Department for the benefit of producers in the several States. A brief summary precedes more extended consideration. I have also endeavored to give in sufficient detail the reasons for the estimates presented to Congress to carry on the work for the coming year.

SUMMARY.

Weather Bureau.—The extension of the Weather Bureau service around the Caribbean Sea has been abundantly successful in noting the first indications of cyclones, forecasting their movements, and giving timely warning to our Navy, to merchant vessels, and to producers and others interested on land.

Division of Chemistry.—This Division is becoming a necessity to every Department of the Government in the making of chemical analyses. Foods are investigated, preservatives of all kinds examined, sugar beets analyzed, etc. An interesting inquiry has been made into the change which takes place in the composition of grains grown repeatedly on the same soil.

Division of Entomology.—Since Dr. Howard has shown owners of Smyrna fig trees on the Pacific coast how to get the fruit fertilized, there is good reason to believe that in a few years we shall obtain our fine figs from that locality. Investigation by this Division shows that house flies and mosquitoes may be greatly reduced by removing the propagating conditions.

Division of Botany.—The Department is gathering information regarding the life history of the plants that supply commerce with india rubber and gutta-percha, and should Congress be pleased to give direction, it will seek the plant zones in our island possessions where these commodities may be produced. The United States now pays $30,000,000 annually for rubber. We import between $4,000,000 and $5,000,000 worth of Egpytian cotton annually. Experimentation indicates strongly that, on suitable soils properly cultivated, this article can be grown here.

BIOLOGICAL SURVEY.—Plants and animals thrive and produce best where they are most at home. The Biological Survey is endeavoring to find the most congenial conditions for our plants and animals.

DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY.—The hybridizing of grains is being conducted by the Division of Vegetable Physiology and Pathology, with a view to securing varieties (rust-resisting, drought-resisting, and cold-resisting) better suited to our varied soils and climates. Hybridization will also be applied in the immediate future to cotton, and efforts are now being made to get a hardier orange tree by the same process. The diseases of plants in the several States, including a serious fungous disease affecting sea-island cotton, and the diseases of fruit trees are also being studied.

DIVISION OF POMOLOGY.—This Division continues to experiment in many localities throughout the country with fruit-bearing trees, plants, and vines. For example, 119 varieties of the finer table grapes of Europe have been grafted on Phylloxera-resistant American stocks and sent to North Carolina and Florida. Special work is being done on the Pacific coast to get more definite data regarding the adaptability of varieties to that locality.

DIVISION OF FORESTRY.—The Division of Forestry is introducing practical and paying forestry on a large scale among lumbermen, and extensive experimentation in tree planting is being conducted, with cooperation on the part of those interested in woodcraft in the several States.

DIVISION OF SOILS.—The irrigation farmer of the West is being helped by the mapping and extended investigation of alkali soils and by the reclamation of injured or abandoned land, many acres of which have become sterile through the injudicious use of water.

DIVISION OF AGROSTOLOGY.—Cropping reduces the organic material in the soil. Long-continued cropping renders the soil unproductive. Grasses and legumes are the best agencies for restoring this organic matter. The Division of Agrostology is experimenting with home and foreign grasses and legumes in all sections of our country, to build up worn-out soils in some cases and to introduce useful varieties in others.

OFFICE OF EXPERIMENT STATIONS.—Cooperation between the Department and the experiment stations becomes closer every year. Assistance from the States is increasing and the farmers of the several States are appreciating their station work more and more. Experimentation in Alaska has begun with Congressional aid. This work should be extended to Hawaii, Puerto Rico, and the Philippine Islands, so that they may be enabled to supply the United States with tropical products, our importations of which amount to over two hundred million dollars annually.

OFFICE OF PUBLIC ROAD INQUIRIES.—There is great interest at the present time in the public highways of the country. Extensive experimentation is being conducted by the Department in cooperation with local authorities in building sample roads from the materials found in different localities, and in the laying of steel track.

DIVISION OF PUBLICATIONS.—During the year 603 publications were issued and over 7,000,000 copies distributed among the people. Of the Farmers' Bulletins, 2,437,000 copies were printed and distributed, which did not meet the full demand.

SECTION OF FOREIGN MARKETS.—Shows rapid growth of American commerce with all parts of the world. We continue to sell raw material to foreign countries, from which they manufacture high-selling articles. Trade regulations are prohibitory against American meats in some European countries where importations of cheap grains from which meats are made are encouraged. The American farmer can not afford to export nitrogenous grains or mill feeds for this purpose.

BUREAU OF ANIMAL INDUSTRY.—The work of this Bureau increases rapidly. Meat inspection was conducted last year at 138 abattoirs in 41 cities. The ante-mortem inspections were 53,223,176, while the number in 1892 was 3,809,459. The third year of experimentation with hog cholera shows that from 75 to 80 per cent of hogs injected with serum are saved. Encouraging results have come from the introduction of dairy products into foreign markets. The Department sends shipments abroad for the purpose of ascertaining the facts regarding such products; these facts are published, and commerce naturally follows.

DIVISION OF STATISTICS.—Fifty thousand crop reporters keep the Division of Statistics informed regarding the condition of our staple crops, and every effort is being made to promptly give the people the facts as they are found.

GARDENS AND GROUNDS.—The grounds of the Department and its extensive greenhouses serve a useful purpose, more than 100,000 plants and bulbs, all of economic value, having been distributed during the year by the Superintendent. This official is now prepared to supply tea plants for experimentation in the Gulf States.

SEED DISTRIBUTION.—The Department in the distribution of seeds is aiming to conform to the original spirit of the law by the importation and distribution of what is rare and valuable.

WEATHER BUREAU.

The establishment of stations around the Caribbean Sea has enabled the Weather Bureau to note the first approach of the West Indian cyclone and to warn shipmasters in port and interested persons on land, with remarkable certainty, of its approach.

EXTRACTS FROM THE REPORT OF THE CHIEF.

The following paragraphs, extracted from the report of the chief of the Bureau, set forth some important features of the work:

COLD WAVES.

Among the most important warnings issued by the Weather Bureau are those which give notice to agricultural and commercial interests of the approach of periods of abnormally low temperature. Warnings of this class have been particularly successful during the past year, and a not unimportant feature of the advices has been estimates of the probable continuation of injuriously low temperatures. In fact, a special effort has been made, and will be sustained, to afford all interests all the information regarding future weather conditions that is warranted by modern methods, appliances, and skill in forecasting. The recognized accuracy of the temperature forecasts have caused them to be closely watched by various interests, and in the commercial centers movements of perishable goods are almost absolutely controlled by advices received from the Weather Bureau.

By far the most important cold wave, or series of cold waves, of the winter crossed the country from the North Pacific to the South Atlantic coasts during the first half of February, 1899, damaging crops and fruits in the Southern States to the extent of millions of dollars. During the first eight days of the month the lowest temperatures on record were reported at points in the North Pacific coast States; from the 9th to the 12th many places in the Central, Western, and Northwestern States reported the coldest weather on record. During the 13th and 14th the cold wave overspread the Southern and Eastern States, attended on the 13th by the lowest temperature on record from the Southern Rocky Mountain slope to the South Atlantic coast, by zero temperature to the Gulf coast of Alabama, and by a snowstorm of unprecedented severity in the Middle Atlantic States.

The Weather Bureau forecasts and warnings gave ample and timely notice to all interests of the advance of the cold wave, and special reports and newspaper comments gave unquestionable evidence that the warnings prompted protective measures whereby crops, live stock, and perishable goods and merchandise to the value of hundreds of thousands of dollars were saved. Along the Middle Atlantic and New England coasts the character of the storm called for the display of hurricane signals, the extreme warnings of the Bureau.

The detailed action taken in connection with this cold wave and storm and the numerous newspaper comments relating thereto, for which space can not be given here, will be found in the Monthly Weather Review for February, 1899. All reports and comments bear witness to the fact that the work of the Weather Bureau in connection with this, the severest cold wave in the history of the Southern States, was as nearly perfect as the most approved methods of disseminating warnings would permit. The amount saved by stockmen in the West and Southwest, by truck growers in the Southwest, and by fruit growers, gardeners, and orchardists in the Southern States, and more especially in Florida, is incalculable. The superintendent of the Florida East Coast Line reports that the warnings sent along his line of road, fifteen hours in advance of the cold wave, alone resulted in saving one-half of the vegetable crop, and that the value of the crop was estimated at $1,000,000. The exceptionally severe character of the storm along the Middle Atlantic and New England coasts amply justified the special warnings sent to that section.

CLIMATE AND CROP SERVICE OF CUBA AND PUERTO RICO.

In the latter part of October, 1898, instructions were given to the official at San Juan, Puerto Rico, to establish a climate and crop service in that island, and later similar action was taken in Cuba. Sufficient instruments and shelters of standard pattern were sent into both islands and voluntary stations established as rapidly as the cooperation of efficient observers could be secured. By the opening of the new year the issue of the Weekly Climate and Crop Bulletin had begun in Puerto Rico, and similar bulletins for Cuba were first issued about the middle of May. The illness of the official in charge unfortunately interrupted the work of the Puerto Rico section, which, however, was resumed in May and has since continued. Arrangements have been completed by which monthly section reports, after the standard, for both Puerto Rico and Cuba will be issued hereafter, work on the first report, that for May, 1899, for Puerto Rico, being well in hand. Notwithstanding the serious difficulties which were encountered in the prosecution of the climate and crop work in these islands, due in a great measure to the fact that the Spanish language is exclusively spoken, much has been successfully accomplished, as evidenced by the fact that both sections issued weekly bulletins with regularity after the middle of May.

From the many courteous and complimentary communications that have been received and notices published in the newspapers, both on the islands and in the United States, it is evident that the efforts to establish this service have been successful and have met a popular need. As the residents of the islands become more conversant with the aims and scope of the service they will appreciate more fully what a great benefit it is, both climatologically and financially.

LOSS OF LIFE AND PROPERTY BY LIGHTNING.

The collection of statistics of loss of life and property by lightning, referred to in a previous report, has been continued. The number of deaths by lightning stroke in the calendar year 1898 was 367 and the number of injuries 494. The places where the proportion of deaths to total population was the greatest were the Upper Missouri Valley and portions of the Rocky Mountain region. The proportion of deaths by lightning in the United States to the total population is about five in a million, which, it may be remarked, is higher than the average of most countries.

Nine hundred and sixty-six barns, sheds, etc., 735 dwellings, stores, and office buildings, 95 churches and schools, and 70 other buildings were struck and damaged by lightning, the approximate loss being about a million and a half dollars. Of the buildings struck, 40 were provided with lightning rods, 855 were not, and in 952 cases it could not be ascertained whether the building was provided with rods or not.

Nine hundred and sixty-four head of cattle, 306 horses, 30 mules, 426 sheep, and 116 hogs were killed by lightning during the calendar year above referred to. The total value of the stock reported killed was $48,257.

Lightning has caused great loss of life and property thus far during the calendar year 1899.

AERIAL OBSERVATIONS.

At the close of the last fiscal year 17 kite stations were in operation and 248 ascensions had been made, in each of which the elevation attained exceeded 1,000 feet. The work was continued until about the middle of November, 1898, at which time 1,217 ascensions of 1,000 feet and over had been made.

The study of the records of temperature, pressure, and humidity thus secured was intrusted to Mr. H. C. Frankenfield, forecast official, whose first report has been submitted. For the first time in the history of meteorology we have facts instead of hypotheses as to the average gradient of temperature up to 6,000 or 8,000 feet, free from all injurious influences, and for so many days and over such a large region of country that it has a broad significance; evidently it is the only proper gradient to be used in reducing atmospheric pressures or temperatures, up or down, from any observer's level. Notwithstanding the imperfections attending the beginnings of any such entirely novel work, these 17 stations, with their 1,217 ascensions in the course of six months, have probably added more to our knowledge of vertical gradients of temperature, humidity, and wind, in the daytime of summer, in the lower portion of the atmosphere, than the sum total of all that was previously known upon the subject.

STUDY OF TEMPERATURES AT STATIONS IN ALASKA.

The Bureau is studying the temperatures at stations in Alaska to learn what effect they may have on rainfall in California, and when cables are laid around the Pacific, with observers stationed at numerous places, the ocean currents and their effect on our Pacific coast, being more intelligently studied, will be better understood. The severe cold wave of last winter that destroyed so many fruit trees suggests the continued improvement of our means of observation.

RECOMMENDATIONS.

The greatest returns from the large sum ($1,022,482) spent annually in the maintenance of the Weather Bureau are from the warnings to marine interests of destructive storms and predictions of cold waves and frosts for the benefit of agriculture and commerce. An appropriation of $95,000 for the purpose of equipping storm-warning stations with improved lights and durable iron flagstaffs and towers from which these important signals can be advantageously displayed is urgently recommended; also an increase of $25,000 in the fund for telegraphing weather reports and improving the river and flood service in order to meet the numerous demands now almost daily made upon the Weather Bureau of this Department by boards of trade, cotton exchanges, marine associations, and large individual owners of ocean, lake, and river property.

DIVISION OF CHEMISTRY.

This Division has continued its study of various soils under identical conditions with satisfactory results. Improved methods of analysis have been devised and published for the benefit of agricultural chemists throughout the country.

Much time and attention has been given to the investigation of food products to ascertain the composition and nutritive value of commercial foods, and definite data have been secured.

Careful and systematic research has been made in this Division for preservatives of all kinds which may have been used on meats. The attitude which the Department should take toward preservatives has been frequently outlined in official reports, but it may be as well to restate it here, as the matter is of great importance. It is well stated in the report of the Chemist, as follows:

> It is not regarded as a wise thing to absolutely prohibit the use of preservatives in foods. Since, however, all chemicals which have the properties of preserving foods also have a tendency to interfere with the processes of digestion, it is held to be imperative that no food should be offered for sale which contains a preservative without having this fact plainly stated upon the label of the package. Not only should the label state that the food product contains a preservative, but it should also give the name of the preservative and the quantity employed. In this way the intending purchaser is fully informed in regard to the character of the product which he buys. While it has been established that a healthy stomach can, from time to time, receive with impunity food containing small quantities of preservatives, it is by no means certain that the continued practice of ingesting preservatives in foods would not produce serious injury. On the other hand, it is also quite certain that weak or diseased stomachs may suffer temporary or permanent injury from even minute quantities of preservatives.

Twenty tons of high-grade sugar-beet seed were imported from Europe for distribution under the supervision of the Chemist. This was sent out mainly through the experiment stations of the States and Territories interested in beet culture. Analyses of beets have also been made by the Division for all recipients of this seed desiring such service.

The State, War, Treasury, Justice, Post-Office, and Interior Departments of the Government frequently call upon the Department of Agriculture to have chemical work done, which suggests the wisdom of preparing to do this work through statutory provision recognizing the Division of Chemistry and providing means to enable it to serve all the Departments.

Deterioration in the gluten content of wheat is being inquired into.

DIVISION OF ENTOMOLOGY.

There are very large numbers of Smyrna fig trees in California that have never matured fruit because the flowers were never fertilized. Dr. Howard, chief of this Division, suggested the importation of an insect (*Blastophaga grossorum*) which in the Mediterranean countries fertilizes this fig. This has been successfully done, and the insects have multiplied and fertilized many figs that matured. Dr. Swingle, who made the importation, is carefully studying the habits of the insect and teaching the owners of the trees regarding it. There is good reason to hope that our country will get its figs in future from the Pacific coast. The Division continues its study of injurious insects that may invade our territory from contiguous countries. Volunteer observers for this Division are studying injurious Puerto Rican insects. Sets of injurious insects are being received from several foreign countries with which we have intercourse. Insects are being studied that are destructive to forests in the Northwestern States. The life history of the San Jose scale, through the work of this Division and State officials, is now well understood. Experimentation in this Division to learn whether this scale would live on dried fruit has convinced most foreign importers that they may safely handle this product.

Investigation is being made by this Division regarding the ability and likelihood of house flies and mosquitoes to carry disease; also by many scientists, who call upon Dr. Howard for exact information bearing upon the life histories of these insects. Life histories of insects injurious to garden crops, grasses, and tobacco are being made out. The Mexican boll weevil is under consideration and the geographic distribution of insects is being carefully mapped, both lines of work in cooperation with local entomologists. Experimental work with remedies and their effects on foliage has been undertaken. The honey bee is being studied along practical lines, such as the preventing of swarming, queen rearing, and the like. Much inquiry comes regarding the large bee of the East, which we will import as soon as arrangements can be made.

DIVISION OF BOTANY.

The many deaths of human beings and farm animals caused by poisonous plants justify continued work by this Division with regard to them. Several hundred tests have been made of seeds bought in the open market, showing that imported grass seed, particularly, requires the attention of the Department on account of its impurities. Dealers in these articles have been warned, and further tests will be made. The work of seed and plant introduction has been attached to the Division of Botany in order to avoid multiplicity of supervision. During the last year explorers have been sent to Russia to secure superior varieties of cereals resistant to cold, drought, and fungous diseases.

One explorer went to Japan to procure varieties of rice possessing high milling qualities, for cultivation under the new system in Louisiana and Texas, by which the rice fields can be flooded when necessary and dried at pleasure to admit the harvester. A testing garden has been secured on the Potomac flats, through the courtesy of the War Department, where observation may be had of plants introduced from foreign countries, so as to avoid new plant diseases. The acquisition of tropical islands by the United States has brought many inquiries to this Division regarding the cultivated plants of the Tropics. There is now widespread interest in tropical agriculture and a demand for correct information on the subject, which the Department must be prepared to satisfy.

BIOLOGICAL SURVEY

During the fiscal year 1898–99 field work was carried on in four States (California, Maryland, Nevada, and Texas) and two Territories (New Mexico and Alaska), and also in British Columbia and Northwestern Territories. In 1898 the principal work was done in California and in 1899 in Texas and Alaska. Work was done under the direction of the chief of the Division on Mount Shasta and in the surrounding country. Several life zones were run from the bottom of the Sacramento and San Joaquin valleys to the summit of the Sierra, and also in other valleys of the Pacific coast. The rapid settlement of Alaska has attracted attention to that Territory. A favorable opportunity for investigation was afforded our biologists through the liberality of Mr. Edward H. Harriman, of New York, who fitted up an expedition for a trip along the Alaska coast.

During the year 1,381 bird stomachs were received and 1,961 were examined in the laboratory. The collection contains 31,300, the accumulation of fourteen years; less than 50 per cent have been examined. Detailed reports of some of this work have been published by the Department. The object is to obtain reliable data respecting the food habits of these birds and to determine their value or possible injury to the farmer. Considerable work has been done to determine whether birds show marked preferences in selecting food or simply eat what is most abundant. Work continues along the line of comparing and tabulating data and mapping the geographic distribution of birds. Similar data have been tabulated for mammals.

The Biological Survey has determined the natural crop belts of the United States and has undertaken to map their boundaries and to prepare detailed lists of the agricultural products adapted to each. A preliminary report on this subject, illustrated by a colored map, has been already published (Bulletin No. 10, Division of Biological Survey). By ascertaining in advance the areas suitable for each variety of fruit, vegetable, and cereal, the Biological Survey aims to put a stop to the present indiscriminate and wasteful experimentation in which farmers spend vast sums of money each year vainly trying to force crops to grow in places unfit by nature for their cultivation.

The crop belts have been found to conform to certain temperature conditions and to coincide with natural belts inhabited by particular kinds of animals and plants, so that their boundaries may be fixed by a study of the geographic distribution of our native species. The work of mapping the life belts can be done only by experienced field naturalists. Persons qualified by knowledge and experience are few and difficult to secure, regardless of compensation. The Department, owing to the limited means at its disposal, has not only been unable to increase the small force long engaged in this work, but has lost several assistants who have resigned to accept better positions elsewhere, for each year members of the Biological Survey are offered salaries much higher than those the Department is able to pay. No increase in the appropriation has been made for seven or eight years, as a consequence of which it is impossible to carry on the work as economically as could be done with a slightly larger and better equipped force. Much time is lost in fitting young and inexperienced assistants to replace those who resign to accept more profitable positions elsewhere; and it is often necessary to extend a piece of field work over several seasons which might be completed in a single season, with a considerable saving in expense.

DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY.

This Division has been making a careful study of plant nutrition, the heredity of plants, and improvement by breeding and selection. While the Department is endeavoring to ascertain, through the Biological Survey, where plants are most at home and under what climate and soil conditions they prosper best, the Division of Vegetable Physiology and Pathology studies the phenomena of plant life itself. The diseases affecting timber are being studied in order that something may be published for the benefit of the public during the forthcoming year. When our people become alive to the necessity of reforesting many parts of our country the value of a correct knowledge of the diseases affecting living trees will be more apparent.

The diseases of trees are as a rule of such a nature as to necessitate much careful investigation to discover the causes. Some are due to unfavorable surroundings, such as soil or plant food, or to the presence of noxious substances in the soil and air. The little-peach disease in Michigan threatens to cripple the peach industry seriously unless some means of checking it are found. A scientist from this Division has been detailed to study the conditions and obtain all the light possible on this disease in Michigan and elsewhere. Definite conclusions have not been reached. The past summer has not been favorable for studying the disease, because during the severe winter of 1898–99 many trees partially diseased were killed outright.

The study of pear blight has been continued, also diseases of white and sweet potatoes. It was found that a serious disease of the sweet potato can be prevented by a simple treatment with formalin solution. A serious fungous disease is affecting the sea-island cotton. One of our ablest men has been detailed to study the matter on the spot. This disease attacks other plants than cotton, and seems to be spreading. The fungus appears to be of great vitality, and may live in the soil for years, attacking the cotton plant when planted again after other crops. In connection with this work it is proposed to inaugurate experiments in breeding cotton, which will have for their object the improvement of varieties of the crop both as regards marketable qualities and ability to resist various diseases.

The pathologist who has charge of plant breeding has been detailed to assist the Section of Seed and Plant Introduction for the greater part of the year, and in Russia and other wheat-producing countries he secured varieties as a basis for future work, in addition to collecting large quantities of cereals for distribution. Another scientist from this Division has been detailed to assist the Division of Soils in extensive work on the curing and fermentation of tobacco. Advances have been made by this Division in the use of pure yeasts for the production of grape, apple, berry, and other wines. The yeasts have been introduced from Germany by agents of the Department. Cultures of these yeasts were made to determine their purity, and after this preliminary work experiments were made to determine their effects upon the fermentation of cider. Our people have been selling apple parings, apple corings, dried apples, and cheap apples by the ton to foreigners, who, with the aid of these yeasts, have been making very desirable articles of commerce. It is designed that our own people shall have the benefit of these discoveries in the future.

Questions have arisen regarding the effects of continued spraying with copper sulphate—as to whether its accumulation in the soil after long use will render the soil sterile. The nature of this work is such that it will take some years to carry it to a successful conclusion.

This Division renders much assistance to the Section of Seed and Plant Introduction by inspecting new seeds and plants, so as to avoid the introduction of new fungous and parasitic diseases, and also by treating the grains imported and distributed by the Department. Plant breeding is attracting more attention than usual. An assistant of this Division was sent to attend the International Conference of Plant Breeders in London during the present year, so as to make himself familiar with the methods pursued in foreign countries. The work that may be done in improving plants by breeding is quite analagous to that which has been done in improving domestic animals by the same method.

The production of large varieties through selections that will improve either plant or animal; the development of varieties for particular purposes, as is done in the case of animals; the cross-breeding of plants, so as to develop varieties that will be more hardy, fungus resisting, drought resisting, early maturing, or late maturing, are all under consideration. It is hoped by hybridizing to get a hardier orange tree for the Southern States, and thousands of cross-bred plants were sent out this spring with this object in view. Seedling pineapples secured by crossbreeding are ready for sending out, and will be placed in suitable localities. Arrangements have been made with the Nebraska Agricultural Experiment Station for cooperative work in crossing corn. An interesting field is offered here, as this cereal is one of the great staple crops of the country, and nothing has been done along this line. Selection has been relied upon altogether for the improvement of this cereal.

The agent of this Division on the Pacific coast is at work on peach-leaf curl and on diseases of lemon, orange, and walnut trees—industries in which the people of the coast are vitally concerned. The crossing of raisin grapes has progressed far enough to warrant the statement that time and judicious work are all that are necessary to obtain the hardiness of plant and the required fruiting qualities in California, Arizona, and Nevada.

The subtropical garden located in Florida is used in making preliminary tests of hybrid fruits obtained in the regular work of the Division and also to test the new plants imported by the Section of Seed and Plant Introduction, about which we desire further information before distribution. This garden has hybrid citrus (orange, lemon, lime) and guava trees and a large number of seedlings. Pineapple plants and imported French grapes are being tested with a view to determine their value for the Southern States.

DIVISION OF POMOLOGY.

The distribution of fruit-bearing trees, plants, and vines has been largely increased during the past year owing to the facilities afforded by the Section of Seed and Plant Introduction, and thus the theories of specialists can have a practical application. During the year 2,700 lots have been placed with about 275 experimenters in various portions of the country. Consul Merriam at Iquique has sent us a lime from the interior of Chile and a reputed hardy type of alligator pear. The last mentioned is being thoroughly tested in the Southern States. A reputed hardy variety from Mexico is also being experimented with.

Experimentation under the direction of the Division is being conducted in North Carolina and Florida, with a view to the successful production of the finer table grapes of Europe. One hundred and nineteen varieties grafted on Phylloxera-resistant American stocks have been planted by the experimenters, as well as 43 varieties of "direct producers" and "resistant stocks." These vines were imported through the Section of Seed and Plant Introduction, and more varieties will be added during the coming year, so as to have thorough and comprehensive tests made of all varieties likely to be useful. A better knowledge of fungous diseases at the present time gives hope that we can produce these fine grapes more successfully than was done a number of years ago, before the science of applying fungicides was so well understood. The results of experiments in root-grafting by this Division are being prepared for publication.

A catalogue of fruits recommended for cultivation in various sections of the United States by the American Pomological Society, which was published in 1897, has been thoroughly revised by a committee of that society working in cooperation with the divisional force. To secure more definite data regarding the adaptability of varieties on the Pacific coast, Prof. E. J. Wickson, of the University of California, was last year appointed a special agent to conduct special investigations on the subject among the growers of that region. Extended preliminary investigations of the conditions of the fruit industry in Idaho, eastern Oregon, and western Washington were made by the Pomologist during the autumn of 1898. The fruit industry as a commercial enterprise is comparatively new in both these sections. The outlook for the commercial fruit grower there is very promising.

The unusually low temperature reached in 1899 worked permanent injury to the trees and vines in many sections. Many that were supposed to be hardy have been killed outright in many localities. The Division of Pomology is endeavoring to ascertain the facts with regard to varieties, so that it may be able to make recommendations for certain localities.

In preparing a horticultural exhibit for the Paris Exposition the Division will secure such fruits especially as are now in demand or may find a market in foreign countries. Canned, dried, and evaporated fruits and vegetables will be shown in great variety. The apple and the orange will be prominent among fresh fruits, and the pecan and shagbark among nuts. Everything is being done along these lines to inform the world regarding our marketable products and to assist merchants in finding markets.

DIVISION OF FORESTRY.

The work of this Division has been entirely reorganized during the year. This and the introduction of practical and paying forestry among lumbermen on a large scale, the extensive investigations in tree planting, preparatory to practical work with tree planters, and the widespread interest and cooperation in the work, especially among lumbermen, are the most important facts to be reported. A striking instance of this cooperation is the action of the redwood lumbermen of San Francisco, who voted to subscribe $1,000, and offered free transportation and free subsistence in their camps to our agents, so as to advance by one year the time when the Division, delayed by lack of funds, could begin work on the growth and reproduction of the redwood.

Notwithstanding the increased appropriation made by the last Congress, it is still utterly impossible to cover the field of necessary action. Very many demands made for work of great importance to the preservation and proper use of forests in the United States can not be complied with for lack of means. It is earnestly hoped that the Division may be enabled during the next fiscal year, through a largely increased appropriation, to take advantage of the unprecedented opportunities created by the rapid public awakening to the meaning and value of practical forestry.

At present all work in the Division is assigned to four sections, each one in charge of a man of special knowledge and qualifications. These are: The section of working plans, which has charge of all practical work in the woods; that of economic tree planting; that of special investigations, dealing with the habits and characteristics of trees which affect their use in practical forestry; and that of office work. But two of the various grades of technical assistants under the heads of sections require mention here.

COLLABORATORS AND STUDENT ASSISTANTS.

The first grade is that of collaborator. The collaborators are experts of established reputation on forestry, lumbering, or tree planting, and are scattered throughout the country. They prepare and forward for publication treatises on subjects previously agreed upon. Through them the best experience of trained specialists becomes available to the Division at a very moderate cost. The pay of a collaborator is $300 a year.

The grade of student assistant was created to provide trained men for the future needs of the Division and to supply it immediately with assistants of high intelligence at small cost. Twenty-eight of these assistants have been employed during the summer, the majority of whom are college or university men. Only those who have declared their intention to adopt forestry as their profession are received. In the field they work under the supervision of trained foresters, especially in the preparation of working plans and the study of commercial trees. The pay of a student assistant is $25 per month.

Both collaborators and student assistants have been of marked value to the work of the Division.

PRACTICAL ASSISTANCE TO FARMERS, LUMBERMEN, AND OTHERS.

Last October a circular was issued (No. 21 of the Division of Forestry) offering advice and practical assistance to farmers, lumbermen, and others in handling their forest lands, with a view of bringing about the substitution of conservative for destructive methods. This offer provided for the preparation of working plans, with full directions for work and with practical assistance on the ground, without cost to the owners of wood lots, but in the case of larger tracts requiring the owners to meet expenses for travel and subsistence, and for the necessary helpers for the agents of the Division while in the field.

During the year applications were received from 123 owners in 35 States for the management of 1,513,592 acres. Of these applications, 48 were for large tracts covering together 1,506,215 acres, the remainder being for wood lots.

Personal attention on the ground was given to 41 tracts, covering about 400,000 acres in 19 States. The contribution of private owners to the expenses of this work was about $3,000.

It was found possible for the owners of a majority of these tracts to carry out the working plans without personal assistance, but 15 of them required the active participation of the Division. On two of the latter, comprising 108,000 acres, the working plans were put into execution early in the year, and the first year's work has been successfully completed. The second year's work is being pursued under very favorable conditions.

As a result of a calculation, based on exact measurements, of the amount of lumber wasted by the prevailing practice of cutting high spruce stumps in the Adirondacks, there has been a decided change for the better on certain tracts, and at the same time a great reduction in the amount of young spruce cut for road building has been brought about. These are important changes.

In connection with the preparation of the working plans for the two large tracts in the Adirondacks, a special study has been made of the growth and production of the spruce on the eastern side of the mountains and of birch and maple on the western slope.

Of the total amount of land submitted for working plans, about 1,200,000 acres have not yet been examined. These tracts will be considered during the ensuing year as fast as the very inadequate force of the Division will permit, and working plans will be made for a selected number.

The Division has been thoroughly equipped with instruments for field work, in which it was wholly lacking at the beginning of the year.

COMMERCIAL TREES.

During the year five species of commercially valuable trees have been studied to determine their rate of growth and to ascertain their special qualities in forestry. The more important of these studies relate to the loblolly pine, in North Carolina, a tree of the first economic importance, and the red fir in Washington, also called Douglas fir, yellow fir, Oregon pine, etc., one of the most valuable and widely distributed trees of the world. These studies have met with the cordial approval of lumbermen, and much practical assistance has been rendered by them. In addition the study of the coast redwood in California has recently been begun, and later, if enough money can be saved for that purpose, the white oak and the hickories will be taken up.

ECONOMIC TREE PLANTING.

The planting of experimental plats in cooperation with State agricultural experiment stations has been discontinued, and the stations have taken over the plantations and assumed the responsibility for them. This was done after a thorough study of the old plan, after careful examination of the plantations at nine of the eleven stations, and with the acquiescence of the authorities of every station. Two other lines of work have taken the place of experimental tree planting. One is a careful study of the results of the planting already done, in which all the species used in the cooperative plantations are represented, and from which practically all the results to be expected from them after many years may be gathered without delay and far more cheaply; and the other the giving of practical assistance to tree planters under the terms of an offer (set forth in Circular No. 22, Division of Forestry) similar to that made to forest owners.

Close relations have been established with five of the most competent men in the treeless regions, and these gentlemen are preparing reports on subjects of direct interest to tree planters.

In addition to the studies now being pursued, the work of the present year will in great measure be devoted, first, to giving practical assistance to tree planters in the selection of the proper trees to plant and in planting them rightly, and, secondly, to an attempt to determine the true effect of bare and wooded or brush-covered slopes on the run-off of streams. The vast interests affected by the solution of this difficult problem will justify the most persistent and careful work.

SPECIAL INVESTIGATIONS.

Forest fires have been studied historically and in the field, and important results have been reached. Records of more than 5,000 fires have been compiled and classified, and field work has been prosecuted in seven States.

A series of studies of North American forests by experts with special knowledge of definite localities is in progress, and it is expected that three of them will be completed during the coming winter.

Historical studies of the progress in forestry in New Jersey, Massachusetts, and other States have been begun, and those for New York are practically completed.

Much material has been collected for a general account of the progress of forestry in the United States and of the practical application of conservative forest treatment in this country up to the present time.

Noteworthy progress has been made during the year in the photographic forest description of the United States.

OFFICE WORK.

The mailing list has been revised and extended, especially among newspapers, and much material for publication has accumulated and awaits attention during the winter. The botanical work formerly carried on by this Division has been turned over to the Division of Botany, where it more properly belongs.

During the year the force has been much increased, largely by the addition of young American foresters. At its highest, the total membership was more than five times that at the beginning of the last fiscal year.

PLANS FOR THE ENSUING YEAR.

Except for the new work referred to above, the plans of the Division, which have received my approval, do not contemplate any material changes from the lines of effort pursued in the year just past.

DIVISION OF SOILS.

FIELD OPERATIONS.

The Division of Soils has continued and considerably extended the investigation and mapping of the alkali soils of the irrigated districts of the West, mentioned in my last report, with results which are at once interesting and practically important to the irrigation farmer. Three field parties have been out during the season mapping a small area in the Yellowstone Valley in Montana; also about 150 square miles in the Pecos Valley, New Mexico, and 250 square miles in the vicinity of Salt Lake City, Utah, with a reconnoissance over a much larger area. Short circulars are being prepared for immediate and wide circulation calling attention to the conditions due to, and the best measures to prevent injury from, alkali or seepage water, as well as the best means for the reclamation of injured or abandoned lands. Fuller reports will then be prepared, with detailed soil and alkali maps on a scale of an inch to the mile, to be published in a volume covering the field operations of the Division during this year.

The trouble from alkali is due primarily to the large amounts of soluble salts generally present in all soils of an arid region. The rainfall is not sufficient to carry off the salts as they are set free in the decomposition of the rocks. These salts are naturally distributed throughout the soil, and for a few years are not harmful. With the application of irrigation water, however, in the intensive cultivation of crops, the excess of water accumulates and is liable to fill up the subsoil, and this, together with the rapid evaporation in an arid climate, shifts the salts until they gradually accumulate at or near the surface in such quantities as to be beyond the endurance of crops. The natural drainage has of course a great influence on such an accumulation of both seepage waters and alkali.

Another, and perhaps the most important, cause of the rise of the subsoil water and accumulation of alkali is in the leakage or seepage from canals. As such damage is liable to be widespread, it is a matter for serious consideration whether canal companies should not be required to protect their ditches from undue loss, and individuals be restrained from overirrigation or made liable for damages in civil suits.

Another source of trouble is in the use of water for irrigation containing too large a salt content. Cases have been brought to my attention where land companies have, through extensive advertising, attracted many settlers, only to deliver water which the companies had previously been informed contained too much alkali for irrigation. Such action only invites widespread suffering and loss to the settlers.

In some districts the condition of the water can be controlled, in a large measure, by the water companies. Reservoirs are frequently lowered for repairs or for cleaning out at the beginning of a long dry period, and the remaining water concentrates by evaporation until it is really unfit for irrigation if the inflow is small and the usual floods are delayed. Furthermore, the first flood after a long dry spell often brings down great quantities of alkali, which have accumulated on the watershed during the dry season. Frequently these first flood waters should be diverted from the reservoirs, in order to prevent serious damage to the community.

These matters are clearly set forth in the report of the chief of the Division of Soils and in his statement of the field operations of the Division, to which attention is called.

RECLAMATION OF ALKALI LANDS.

When the alkali contains considerable quantities of carbonate of soda, the usual remedy is heavy applications of gypsum with drainage, if necessary, to insure thorough aeration of the land. When the other alkali salts or seepage waters have accumulated in excessive quantities, drainage is necessary.

So sudden and unexpected is the damage from the rise of seepage waters and alkali that estates worth thousands of dollars may have to be abandoned in two or three years, with an utter depreciation of value. So widespread is the damage that in one tract alone near Salt Lake City there are 100 square miles of practically abandoned land, partly within the city limits, formerly containing some of the most fertile lands of the valley, which would have, under a conservative estimate, a value of over $3,000,000 if the original conditions could be restored. With the encroachment of the alkali the farmers are moving back on the higher levels.

The matter of artificial drainage, as a means of preventing damage and of reclaiming alkali lands, has been so often advocated without attracting the attention necessary to induce action, and the matter is of such vital importance to the West, that I have recommended to Congress an appropriation of $10,000 for the purpose of actually demonstrating the practical utility of the different methods of treating such lands.

SOIL MAPPING IN THE EAST.

Equally important work is being done in the eastern district of the country. Part of this will be referred to under "Tobacco investigations."

The methods of field soil surveys have been worked out in the past few years in this Department, and men have been carefully trained for such work. As no such training exists elsewhere in this country, several of the experiment stations and State geological and economic surveys have been glad to avail themselves of the cooperation of the Department, thus, while contributing to the expenses of the work, being relieved of the direction and responsibilities of making soil surveys of their States. Thus, a detailed soil survey has been undertaken of the soils of Maryland, in cooperation with the geological survey of that State, and of Louisiana, in cooperation with the State experiment station. Such cooperation will be encouraged so far as competent men can be obtained and the means at our disposal will permit. Other States are willing to contribute money, but the difficulty has been to obtain men and to find the time required to train them. There is a wide and valuable field in this work for the graduates of our agricultural colleges who are willing and able to undergo the necessary training.

TOBACCO INVESTIGATIONS.

The investigations of the tobacco soils of the country by the Division of Soils has shown so much of importance that last year I asked Congress for an appropriation to extend and supplement this work. This request was granted. The money was not available until the first of July, 1899, but since that time a large amount of the most important work has been done, which will be referred to in my next Annual Report. Briefly, this work includes the mapping of 400 square miles in the Connecticut Valley, including the principal tobacco areas of that important locality. This map, which is being prepared for publication, shows the character of the soils and their distribution.

The soils occur in more or less well-defined terraces, formed by the old lake which covered that area in prehistoric times. The highest terraces, or the old lake bottom, are coarse sand, containing fine gravel. These "plains" soils produce the finest wrapper leaf when the season is favorable, but on account of the droughty character of the section such crops are only obtainable about two years in five. Some practical method can no doubt be found to make the crop more certain.

The next lower terrace is of finer sand, and it is upon this that the general crop of Havana seed leaf is produced. The next terrace is of still finer sand and produces the fine broad-leaf variety, while the lowest terrace, or the present meadows, is of such fine silt that it produces a coarse dark tobacco unsuited to the present market demands. There are other soils upon which tobacco can not be grown, and still others upon which tobacco of peculiar properties is produced, suited to certain trade. The map will show these soils in different colors.

CAUSE OF THE FERMENTATION OF TOBACCO.

To supplement this soil work, the Division of Vegetable Physiology and Pathology is cooperating in the study of the cause of the fermentation of tobacco. It has been found that the flavor and aroma are due not to bacteria, as was formerly supposed, but to enzyms or oxidizing agents in the leaf itself. The formation of these oxidizing agents and the conditions of their greatest activity are being studied.

It has been found that some of the soils of the Connecticut Valley are similar in all essential respects to the soils of Florida and Cuba, and an effort will be made, through changes in the methods of cultivation and fermentation based upon these investigations, to improve the quality of the Connecticut leaf so as to adapt it better to the present demands for wrapper for high-priced cigars. Next year it is proposed to investigate the soils of Pennsylvania and Ohio to see if the quality of the filler leaf grown on the heavier soils of these localities can not be greatly improved.

PHYSICAL AND CHEMICAL INVESTIGATIONS.

To supplement and support the field work of the Division, various investigations are being carried on, partly with the cooperation of the Division of Chemistry, in relation to many intricate soil problems, such as the retention and movement of the water through soils; the physico-chemical effect of fertilizers in soils; the absorption of salts; the physical properties of loams and clays; the plasticity of clay; the formation of hardpan, and similar subjects.

These matters are exceedingly intricate and difficult to work out, but the vast importance of the economic problems depending upon these properties of soils justifies a prolonged and searching inquiry into them.

Several instruments and methods have been devised and perfected in the Division of Soils which are of distinct advantage in these lines of soil investigation. Furthermore, the very large and valuable collection of over 4,000 samples of soil supplies very valuable material for these laboratory investigations.

DIVISION OF AGROSTOLOGY.

NATIVE GRASSES.

It is acknowledged that there is no country in the world so rich in the number and variety of useful grasses and forage plants as the United States. The investigations of the Division of Agrostology have demonstrated that the country abounds in native species adapted to nearly every variety of soil and climate and to almost every requirement. There are upland and lowland varieties, there are woodland and prairie species, there are kinds which exist only in the humid regions along the coast, and there are others which thrive in the arid regions of the interior. Some are productive hay grasses or afford abundant grazing, while others again are valuable for fixing drifting sands or reclaiming impoverished or waste lands. There are decorative species for the garden or lawn, and not a few are useful in the arts and manufacture. Grasses are chiefly important, however, as food plants for all kinds of stock, yielding beef, mutton, and other animal products, which are a source of great wealth to the country, and their investigation along these lines is a most useful and essentially practical work of this Department. The fine quality of the forage afforded by the native grasses of our vast cattle ranges is a matter of world-wide comment; the perpetuation and improvement of the most valuable sorts are matters of extreme importance, and these may well be the subjects of practical scientific investigations at our hands.

COOPERATIVE EXPERIMENTAL WORK.

In addition to the continuation of the work already established in Texas, other experiments have been instituted during the year in the

States of Washington and South Dakota. The results obtained in Texas clearly demonstrate the possibility of materially improving worn-out pastures and ranges by practical methods of treatment. Tests have been made of a number of promising drought-resistant grasses and forage crops, and some of these have shown great hardiness, as, for example, some of the saltbushes, sorghums, and vetches, as well as such native varieties as Colorado grass, blue grama, black grama, and wild rye. On the Pacific coast the most extended tests have been made at Walla Walla, Wash. Among the varieties giving best results at this point may be mentioned sainfoin, Australian saltbush, blue grama, smooth brome, Oregon rescue grass, slender wheat grass, Japanese barnyard millet, Turkestan alfalfa, and some of the vetches. Most of these varieties show characteristics which will render them adaptable to the conditions which prevail over large portions of the great range regions of the West and Northwest. Thus, smooth brome has exhibited great vitality, surviving prolonged drought as well as extreme cold, and affording good returns of pasturage, hay, and seed under conditions that would destroy the ordinary grasses; the saltbush promises to be of much value on land strongly impregnated with alkali, and blue grama and the wheat grasses seem destined to become our most valuable means for reclaiming the many thousands of acres of range lands that have been all but ruined by protracted droughts and overstocking.

The work at Highmore, S. Dak., which is being carried on in cooperation with the State experiment station has for its object the testing of drought-resistant grass and forage crops, with a view to finding varieties suitable for the pastures, meadows, and ranges of the semiarid prairies east of the Rocky Mountains. Although but recently undertaken, the work is well in hand, and has already given results of practical value.

By means of these experiments we are learning that many of the native grasses adapt themselves readily to cultivation in our meadows and pastures, in some cases proving of more value than any of the introduced varieties yet tried. It is also being demonstrated that these native grasses are susceptible to improvement by careful cultivation and selection, and forms are being developed that give promise of much greater adaptability to farm conditions than the parent stocks.

There are many native leguminous forage plants, and some of these are also giving good results under cultivation. The Metcalfe bean of the table-lands of New Mexico is one of these. It not only does well in its native section, but has made excellent growth on the Pacific coast, and gives promise of being a valuable forage plant for the dry uplands of the West.

As in former years, most of the experimental work connected with the grass and forage plant investigations is carried on in cooperation with prominent farmers in various parts of the country, to whom seeds are sent for this purpose. During the year 1,600 packages of seeds, comprising 185 varieties of grasses and forage plants, have been distributed in this way. These seeds include choice varieties imported from foreign countries, in the hope that they will show special adaptability to the conditions which prevail here, and native sorts, collected by agents sent into the field to study the plants in their natural condition and to select those possessing characters of particular value for cultivation. In this way it is being demonstrated that many of our recently introduced varieties are likely to have a wide range of usefulness, and that some of the commonly grown sorts deserve to be much more generally cultivated. Japanese barnyard millet is not only a most valuable crop for the New England States, but has given excellent results in many places in the South. Rescue grass has been grown in the South for many years, but many know little of its value as a winter forage or how to cultivate it. The legumes ought to be much more widely grown in the South, and will be when their great value, not only for food, but as restorers of nitrogen to impoverished soils, is more fully understood and appreciated.

GRASSES AS SAND AND SOIL BINDERS.

The large areas of drifting sands along the Atlantic, Pacific, and Gulf coasts and also about the Great Lakes and along some of our larger rivers, which, because of their unstable character, are a serious menace to life and property, could in many cases be reclaimed and converted into valuable pasture and meadow lands. The study of the grasses suitable for binding these sands has been extended along the Atlantic coast as far south as Florida, also to various points on the Pacific coast and along the Columbia River in Washington and Oregon. Several native sand binders of great promise have been discovered, and their utilization in a practical way has been undertaken. The seaside blue grass, a native of the sand dunes along the Oregon coast, where it grows abundantly, is said to be a good forage grass as well as an excellent sand binder, and has been successfully introduced along the sand dunes of Lake Michigan. The binding of drifting sands and embankments about fortifications along the coast is a serious problem which confronts the authorities of the War Department, and at their request some experiments have been made during the year on Tybee Island, at the mouth of the Savannah River. Here, as on the Pacific coast, one of the native grasses promises to be of greatest value.

THE GRASS COLLECTION.

Important additions have been made to the grass collection, including valuable material from abroad as well as from our own country. In all, 6,246 sheets of mounted specimens have been added to the herbarium and nearly 4,000 determinations have been made for correspondents.

PLANS FOR FUTURE WORK.

The great importance of the problems connected with the forage supply of our country—the close relation which it bears to the welfare and prosperity of the agricultural classes and the increase of public interest in grass and forage-plant investigations—make it imperative not only that the present lines of investigation should be continued, but that new ones be undertaken. The investigations under way in the Gulf-coast region and on the Pacific slope ought to be extended in their scope; the work on range improvement should be continued along the present practical lines; the investigations looking toward the preservation and improvement of our most valuable native grasses and forage plants should be continued; the study of soil and sand-binding grasses ought to be extended to include experiments as to the adaptability of our native sorts to practical use for fixing the shifting sands of our coasts and for holding embankments in place, as well as to the introduction of desirable foreign sorts; investigations relative to the introduction, cultivation, and management of improved pasture and forage crops on the abandoned farms of New England should be undertaken; the question of forage crops suitable to alkali soils is one of much importance to certain sections of the country, and should receive full and careful investigation. There is no question as to the value and importance of investigations along all the lines indicated, and an increase in the appropriation for the Division is recommended in order to effectively carry on the work.

OFFICE OF EXPERIMENT STATIONS.

RELATIONS OF THE DEPARTMENT TO THE STATIONS.

The relations of the Department of Agriculture to the experiment stations of the several States become closer every year. An increased amount of assistance is given every year to the State experiment stations to enable them to carry out work of a national character. Cooperative work between the Department and the stations is gradually increasing. The Department is consulted oftener regarding the organization and management of the stations, the choice of officers, the lines of work to be undertaken, the execution of special work, plans for station buildings, materials and apparatus required for use in connection with the different kinds of agricultural investigations, etc.

The Department has been able to bring some influence to bear against the frequent change of station officials, which has been too common in certain States. At the same time no effort has been made to interfere with the independence of each as a State institution. The farmers of the States are appreciating the stations more and more, giving them attention, requiring better work, securing State funds, and interesting themselves in the management and supervision. This is having an excellent effect and resulting in better work for the communities in which they are located, all along the line.

NATIONAL AND STATE AID TO THE STATIONS.

The stations in all the States and Territories are visited regularly every year by officials of the Office of Experiment Stations, whose report is transmitted annually to Congress for the information of the national legislators. Where the experiment station is a part of the agricultural college of the State the connection has a beneficial influence on the course of instruction, as the work of the station in the interest of the locality has a tendency to better instruct the officers of the college engaged in teaching. There is much need that the endowment of the Federal Government should be supplemented by the State in nearly every case, and many of the States are appropriating money to enable the stations to extend their work. The erection of buildings for the colleges has often been done for the purpose of increasing the facilities for experiment-station work.

The printing of station bulletins in a number of the States is regularly done at the public expense, while some of the stations are unable to publish the results of their experimental work for want of means for the purpose. Experimentation has been begun in Alaska with the aid of national funds. In each of the States of Alabama, Connecticut, New Jersey, and New York a separate station is maintained wholly or in part by State funds. The Louisiana experiment station, supported for a number of years by the sugar planters, is now under the management of the State. Every year the sum of $720,000 is paid to the several stations by the National Government, while nearly $500,000 is paid by the States, individuals, communities, and as fees for analyses of fertilizer, etc.

THE FUNDS OF THE STATIONS.

It has happened occasionally that boards of trustees have diverted experiment station funds to college purposes. The opinion of the Attorney-General of the United States has been had on this subject. According to this opinion, no portion of the funds appropriated by Congress in accordance with the terms of the act of March 2, 1887, can be used, either directly or indirectly, for paying the salaries or wages of professors, teachers, or other persons whose duties are confined to administration, teaching, or other work connected with the course of instruction given in the colleges with which stations are connected, or in any other educational institution, nor should any other expenses connected with the work or facilities for instruction in school or college courses be paid from said fund.

THE STATIONS CENTERS OF INFORMATION FOR LOCAL REQUIREMENTS.

In the development of methods of investigation and special apparatus the Department can now accomplish much more than any one of the stations. On the other hand, the stations are, to an increasing extent, becoming centers of information and authority on the lines of work in which they have been engaged with special reference to the local requirements of agriculture, and in some instances the stations, through the liberality of State governments or connection with strong colleges and universities, are in better position than the Department to carry on investigations requiring the knowledge and skill of experts or expensive forms of special apparatus.

By recognizing the authority of the stations in their several localities, securing the services of their expert officers, and the use of special facilities at their command, it is believed that the Department may oftentimes most economically expend the funds intrusted to it by Congress for special investigations, and can at the same time devote the energies of its officers more fully and effectively to the large enterprises for the promotion of the science and practice of agriculture.

THE EXHIBIT AT THE PARIS EXPOSITION.

An exhibit of the publications of the stations and of the Office of Experiment Stations, with photographs and charts showing the buildings and equipment of the stations, special features of their work, an illustrated report on the history of the stations, and a collection of special devices for station work, with illustrations of notable results by means of models and otherwise, will be made at the Paris Exposition. Investigations in Alaska, in nutrition, and in irrigation, in charge of the Department, will also be included in this exhibit. The materials for the exhibit will be largely furnished by the stations.

NEED OF STATIONS IN THE NEW POSSESSIONS.

There is a pressing necessity for the establishment of experiment stations in Puerto Rico, Hawaii, and the Philippines. The newer and more intimate relations existing between these islands and the United States, the responsibility assumed by the United States regarding them, and the necessity for giving to the peoples of those islands information regarding their staple crops, their development, and the insect and bacteriological pests to which they may be liable, suggest the necessity of scientific investigation of everything pertaining to production. These stations will be needed in our island possessions much more than they are needed in our States and Territories. Special investigations along these lines will not take the place of permanent experiment stations.

There is no method of informing the tiller of the soil so valuable to him as to have practical scientists studying the conditions of production in his neighborhood. There is thus provided not only an object lesson, but the foundation of a farm literature. A local station should be placed in each of the groups, on land belonging to the Government, with buildings and equipments for field and laboratory investigations, for careful surveying of the agricultural capabilities and requirements of the lands, cooperative experiments with interested farmers, the dissemination under frank of bulletins of original and compiled information, and the holding of farmers' meetings in different localities for the diffusion of practical information.

In general, there should be a systematic effort to disseminate useful information on agricultural subjects among the people and to gain new knowledge which may be utilized for the benefit of the agriculture of those regions. Educational influences of this nature established among the peoples of the islands will not be the least potent influences in elevating them to higher intellectual levels. Fifteen thousand dollars could be wisely appropriated for Hawaii, $10,000 for the Philippines, and $5,000 for Puerto Rico. These stations for the present should be under the direction of the Secretary of Agriculture until such time as, under the benign influence of the United States, the people in the islands are thoroughly prepared to take charge of institutions of this kind and manage them for themselves.

INFORMATION REGARDING WORK OF THE STATIONS.

A series of Farmers' Bulletins, based on the work of the experiment stations, for the purpose of disseminating throughout the country information regarding the work of the stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation, on its practical side, has been printed by the Office of Experiment Stations. The demand for this class of Farmers' Bulletins is growing very rapidly. The aim is to provide our farmers with a popular record of the progress of agricultural research.

WORK IN ALASKA.

Work is progressing in the establishment of an experiment station in Alaska. Prof. C. C. Georgeson, a thoroughly educated and practical experimenter, has been put in charge of the work. Headquarters for the present are established at Sitka, and a building is being erected there for the convenience of the scientists connected with the station work. Seeds have been distributed among different localities in Alaska, and measures instituted to obtain information regarding the crops, methods of cultivation, feeding of animals, and agricultural possibilities of the different regions.

Professor Georgeson is experimenting in the growing of different varieties of cereals, forage plants, flax, and vegetables in gardens placed at his disposal by citizens of Sitka. In spite of late planting, oats, barley, potatoes, flax, and a number of different kinds of vegetables of good quality were matured. Clover and grasses made an excellent growth. Useful data were also obtained from these experiments regarding the effect of different soil conditions on the germination of seeds and the growth of plants. Experiments similar to those being conducted at Sitka were made at Skagway.

Observations regarding soil temperatures are being made at Sitka and Skagway, and arrangements for similar observations will be made at other places. Samples of soil were collected at Sitka, at Kenai, and at Cooks Inlet, for which the moisture determinations were made under the direction of the chief of the Division of Soils in this Department. Circulars of inquiry regarding the agricultural conditions in different parts of Alaska, including both the coast region and the interior, were sent out, and a number of replies were received and reported. A number of places on the coast region of Alaska have been visited and surveys and reservations of land for experimental purposes have been made at Sitka, Kadiak Island, Kenai, and Cooks Inlet.

Botanical investigations in Alaska under Dr. Evans, of the Office of Experiment Stations, have been carried on during the past year. A considerable number of specimens of the flora of the coast region were collected. Several species were found that may prove of considerable value as sand binders, for which there is great need in many localities of the United States.

Careful experimentation with grains grown in northern latitudes is being made. Efforts will be made by selection, and probably through the results obtained by crossbreeding, to find grains suitable for that territory. The effect of draining the soil is being tested, and the use of the silo for preserving stock feed is being demonstrated.

HUMAN NUTRITION.

Several bulletins on the subject of human nutrition have been issued by this Office during the past year. "The chemical composition of American food materials" (Bulletin 28, revised edition) contains the maximum, minimum, and average of 4,000 analyses of American food products, and gives a large number of analyses made since the first edition was issued. As a standard table of food analyses, it is, therefore, much more full and complete than any table which has preceded it. "Dietary studies in Chicago" (Bulletin 95), by W. O. Atwater and A. P. Bryan, contains a report on the food habits of fifty foreign and three American families in the congested west side of Chicago. "Fish as food" (Farmers' Bulletin 85) and "Sugar as food" (Farmers' Bulletin 93) contain a considerable amount of information derived from the reports on nutrition investigations mentioned elsewhere.

IRRIGATION INVESTIGATIONS.

BEGINNING OF THE WORK.

The first appropriation for irrigation investigations became available July 1, 1898. The literature of irrigation, especially that containing accounts of experimental inquiries, was collated and reviewed, and correspondence was had with experiment station officers, State engineers, and other experts who were devoting their energies to the study of irrigation problems in this country. A conference of station officers and engineers was held in Denver July 12 to 13, 1898, at which the needs of agriculture under irrigation were earnestly considered and much valuable advice regarding plans for the work of this Office was obtained.

As a result of this preliminary inquiry, it was determined to limit the work of this Office under the appropriation to two general lines: First, the collation and publication of information regarding the laws and institutions of irrigated regions in their relation to agriculture; and, second, the publication of all available information regarding the use of irrigation waters in agriculture, as determined by actual experience of farmers and experimental investigators, and the encouragement of further investigations in this line by the experiment stations. Prof. Elwood Mead, State engineer of Wyoming, was asked to undertake the direct management of the investigations in charge of this Office. Two irrigation bulletins were completed within the fiscal year for which the appropriation was made. A report was also made to Congress on the usefulness of storage reservoirs as a part of the irrigation system. Thirty-five thousand dollars have been appropriated by Congress for the work of the present year, measures have been taken to organize the work on a more permanent basis, and an expert force with sufficient clerical assistance has been formed. The subjects requiring investigation are numerous. The conditions and needs of different localities vary, and the demand on the part of the people for more immediate information in so many lines is so urgent that much attention will have to be given to the selection of lines of work to be undertaken.

NEED OF EXPERTS.

One great difficulty is to find an adequate number of men who have had proper training to fit them to prepare publications or carry on investigations in the manner which our work requires. As a rule, the men who are best fitted for this work are engaged in other enterprises and can not be induced to enter the Department's service on the terms necessarily imposed. In this, as in other special lines of investigation which the Department has undertaken, it will be necessary to organize a force to work under the immediate direction of the expert in charge, and some time must elapse before this force can be thoroughly trained so as to perform the most efficient service. Considerable effort has been made to ascertain who are available candidates for positions in this service. The establishment of agricultural colleges for education in the sciences relating to agriculture has done something toward preparing scientists in several directions, but there are many lines in which very little has been done, and this is one of them.

When the Department requires soil physicists, plant pathologists, or scientists well informed regarding animal husbandry and irrigation, it has been found almost impossible to get them. The Western agricultural colleges, where scientific knowledge of the facts concerning irrigation is most imperatively necessary, are making vigorous efforts to educate along these lines. The boards of management of the stations have been led to see the importance of the work in irrigation which the Department has undertaken, and are moving in the direction of the employment of a large number of competent investigators who can work in cooperation with the Department. There must be a period in which the training of experts, both by the Department and the experiment stations, will be the most important features.

REASONS FOR A GENERAL STUDY OF THE SUBJECT.

The need of an impartial and thorough study of water rights and the laws and methods of enforcing them is so urgent that the Department has been under continuous pressure from the people of the arid States to devote all the funds for irrigation investigations to this branch of the subject. The immense area embraced in the irrigated regions, the wide difference between the laws and methods of the different States, and the complexity and number of the problems to be considered have required the expenditure of a great deal of time and thought in the organization of this investigation. It is the intention, if sufficient provision is made, to include all the arid and semiarid States in this study during the coming year. In each of these States the law and methods differ widely. Even where conditions are of a similar nature, titles to water and methods of distribution are wholly unlike.

There is a second reason for making the investigation general. Many most important rivers are interstate streams. Some of them are used for irrigation in half a dozen different States. The water rights of these several States deal with a common supply. They vary so widely in their character that there must sooner or later come a time when their differences must be reconciled, or at least be brought to the attention of the Federal Government, and become a subject of legislation by Congress. It is of the utmost importance that before either of these things occurs there should be a thorough understanding of the character of the rights which are vested under these laws and of the disturbances which will ensue if a uniform or interstate system of water rights should be put in force. It is only through the collection and publication of these facts that either the several States or Congress can intelligently determine whether or not the control of rivers used in irrigation should be left exclusively to the States, as is done at present, or whether the present practice should be overturned and the streams be divided under the operation of federal laws and under the control of federal officials.

Measurements of the actual volume of water used in irrigation and the time of such use are being carried on in fifteen States and Territories. An approximate knowledge of the quantity of water required to irrigate an acre of land growing any given crop is sooner or later a necessity in any irrigated district. Farmers, canal builders, water commissioners, State lawmakers, and Congress all need this information in the making of water contracts, the planning of works, and the determination and protection of rights in streams. Without it all these important transactions are largely based on conjecture. The mistakes to which this gives rise are a serious obstacle to the conservation of the water supply and its orderly division.

It is the purpose of this investigation to begin the collection of this information, but in order that it may have general acceptance and value the facts secured must embrace a wide range of conditions and crops and be continued through a series of years, in order that accidental variations of seasons may be eliminated. Before the investigation is ended it is expected that it will embrace a study of more economical methods and a determination of the extent to which the reclaimed area can be extended thereby; but at the outset it is desired to ascertain what is the common practice of irrigators.

The method of measurement adopted had to take into consideration the fact that the demands of crops are not the same during different seasons of the year, nor is the supply uniform. Streams rise and fall. The adoption of any device for delivering a uniform flow would not, therefore, meet the demands of either the users of water or the character of the supply. What has been done has been to provide for keeping a constant record of the amount used, without any regard to the intentional variations in use or the accidental changes in the supply. To do this it has been arranged to measure the depth of water passing over a weir or flowing through a flume, and from this record to compute the amount of water used.

One object of the studies on the duty of water is to secure greater economy in its use, the reclamation of an increased area, and a larger yield of crops through its more skillful application. Something more is necessary than measurement of the quantity employed. The factors which tend to produce a high or low duty must also be studied. These include the amount of rainfall, records of temperature, rate of evaporation, character of soil, losses in transportation in canals, the merits of different methods of distributing water over the land,

and the influence which is exerted by the character of private water-right contracts for delivering water or of State laws governing titles thereto.

Before we can rightly estimate the value of reservoirs we must know not only the amount of water required by different crops, but the time when such water is needed. The purpose of reservoirs is to bring fluctuations in stream flow into harmony with the variations in the demands of crops. A dependence on the natural flow of many Western rivers permits of only a small fraction of their natural discharge being utilized, because the waters run to waste before or after they are needed. We must know when the water is needed, and how much is needed in different months of the year, before we can rightly estimate how much must be stored in order to utilize the entire supply.

The character of water-right contracts has much to do with the economy or waste which prevails in irrigation. Many of these contracts have been prepared by people having little practical knowledge of the subject. Among the classes of contracts which have been productive of either discontent or abuses are, first, perpetual water rights. Under these contracts the user pays a certain amount per acre for all the land on the canal, whether he irrigates it or not. These contracts usually specify a certain duty which has been fixed before the needs of the lands or the crops to be cultivated were known. Sometimes this duty is so low as to be a direct incentive to waste; in others, so high as to be manifestly one-sided and unfair.

A second class of contracts comprises those for the delivery of the water used at a specified rate per acre, without regard to the economy or waste of the irrigator. These contracts lead to controversies, because of the temptation on the part of the irrigator to use all he can, regardless of his necessities, since in that way he gets more for his money; while on the part of the canal owner the temptation is to agree to provide water for as many acres as he can without regard to his ability. The objections to these two classes of contracts are leading to the evolution of a new system in which payment is made for the quantity of water used.

The usefulness of this investigation is not limited to the arid region. On the contrary, there is no question but that irrigation can be profitably employed in the cultivation of large areas in the Eastern and Southern States. A hundred thousand acres of sugar land are being irrigated in Louisiana. Irrigation of the rice fields in the Carolinas is very extensive. The market gardener could profitably use irrigating waters. Irrigation is being experimented with in the growing of tea in South Carolina. Prof. E. B. Voorhees, of the New Jersey Agricultural Experiment Station, is collecting data on the area of land now irrigated in that State, the methods employed, the duty of water obtained, and the benefits received.

Many of the valleys of the mountain States are being injured seriously by the injudicious use of water. Wherever the soil contains alkali, it is being brought to the surface when too much water is applied, and the land thereby rendered infertile.

More than one-third of the country depends upon the success of irrigation to maintain the people, the industries, and the political institutions of that area, and future growth will also be measured by the increase of the reclaimed area. In a region which, in the extent and diversity of its mineral wealth, has no equal on the globe, the riches of the mines in the hills are already surpassed by the productions of the irrigated farms in the valleys, and the nation at large is at last awakening to the fact that the development of the use of the rivers and arid lands of the West will constitute one of the most important epochs in our increase in population and material wealth.

It is not possible at the present time for the owner of an irrigated farm to know exactly what his right is. The nation has made no provision for the distribution of either the natural flow of the streams or the stored water. The States vary greatly in their enactments regarding the use of water. If the control of this element of production is to be left to the States, there should be a definite declaration to that effect. If it is to be assumed by the General Government, it should be done at once.

OFFICE OF PUBLIC ROAD INQUIRIES.

INQUIRIES REGARDING ROAD-MAKING MATERIAL, ETC.

Something has been done during the past year by the Office of Public Road Inquiries to ascertain what can be accomplished in making roads by the use of the material found in the several States. Cooperation has been had with the experiment stations of several States in making steel roads, macadamized roads, and gravel roads. The people of all the States are very much interested in the improvement of their public highways. There is a great demand upon the Department of Agriculture for assistance in road making, in addressing the students at our agricultural colleges, and in giving instruction regarding the best methods of using what material may be found convenient. Publications have been sent out from the Department covering the several features of road making, and for these there is great demand. Much attention is being given to this subject by the legislatures of the several States of the Union.

I am of the opinion that it would be wise to have the resources of the Eastern, Southern, Middle, and Western States carefully inquired into by the appointment of competent men in each of these sections who would ascertain and report upon the road-making material obtainable, and at the same time give instruction in the actual construction of roads. There is also a necessity for scientific inquiry into the composition of road material in the several sections of our country, and the facility with which these materials when brought together combine to make good highways. Many sections of our country have within reach hard rock from which good roads can be made. Other sections are entirely lacking in this regard, and must, in my opinion, eventually look to steel tracks for supplying permanent good roads.

In order to get information along these lines, short sections of steel track were laid during the past year at Omaha, Nebr., Ames, Iowa, and St. Anthony Park, Minn. The Western States are not well supplied with stone and gravel for road-making purposes, and the people of these States are watching these experiments with great interest. It is our intention to encourage the laying down of steel-track sections during the coming year wherever we can induce the localities to purchase the steel. We do not yet know what is the best shape for the steel rail, nor do we know the best material to lay between the tracks, but inquiry is being made along these lines and information is being gathered from experience.

The people of the United States have associated themselves into national and State organizations for the purpose of encouraging the building of better roads and for the consideration of ways and means to that end. There is a great deal of agitation and considerable education along road-making lines. The people of many localities are exceedingly anxious to have the cooperation of the Department in improving their roads, and demands of this kind are so numerous that our limited force is entirely inadequate to give the assistance required. The object-lesson road work of the year has been as extensive in territory covered as it has been far-reaching in results accomplished. Model roads of various kinds have been built, under the supervision of agents of the Office of Public Road Inquiries, in Maryland, Nebraska, Minnesota, Iowa, Kentucky, Indiana, and Wisconsin. Elementary knowledge of road making is being rapidly spread among the people. Students at our colleges are taking a great interest in the study of road making. Gentlemen of means, enterprise, and public spirit are doing much along experimental lines for the education of their neighbors.

PRINCIPAL INQUIRIES OF THE YEAR.

The principal inquiries during the year were upon the following subjects: New road legislation, especially as regards State aid; the use of convict labor in road building or in the preparation of road material; experiments with steel roads and other new plans; methods of raising road funds; conditions of new roads under wear, especially the sample roads designed by officers of the Office of Public Road Inquiries; the promotion of rural free delivery of mails by good roads; the progress of organizations for road improvement; the prospects for road construction in several localities. The invention of road graders for use in the great productive prairies of the West has simplified the construction of roads more than any other one feature of progress. The value of these graders in making roads by horsepower is not well understood in all parts of the United States.

RECOMMENDATION.

The great activity on this line among the people of the United States during this fall, and the necessity of getting facts for use in the several localities of our country, induce me to recommend that Congress increase the appropriations of this Office sufficiently to justify the appointment of four experts, so that information can be gathered regarding valuable road material and cooperation be had with experiment stations, colleges, and universities, and with the men of enterprise who are now actively seeking such information and such assistance.

DIVISION OF PUBLICATIONS.

NUMBER AND COST OF PUBLICATIONS.

During the year 603 different publications were issued, aggregating 26,420 pages of printed matter, and the total number of copies was 7,075,975, greatly exceeding the work of any previous year. Of this number, 176 were Farmers' Bulletins, of which 2,437,000 copies were printed and distributed. The cost of printing these publications was $91,966.59, and of blanks, blank books, etc., $36,624.93, making the amount expended for this purpose $128,591.52. There was paid for artists and illustrations, labor and materials in connection with the distribution of documents, and for artists' supplies, $29,836.55, making the total expenditures under the supervision of the Division of Publications, exclusive of the amount appropriated for statutory salaries, $158,428.07.

In this connection, it may be said that the care and prudence which have characterized the management of the Department printing are strikingly manifested by a comparison of the number and cost of the publications since the period when the Division was first established. In 1891, the first year when the Division was fairly organized, there was expended for actual printing 59.8 per cent of the total appropriation for that year, while 40.2 per cent was expended for editing, illustrating, and distributing, whereas in 1899 of the total appropriation for printing only 27.1 per cent was absorbed for editing, illustrating, and distributing, leaving 72.9 per cent available for actual printing. Thus, in 1891, when the total appropriation was $87,600, the number of copies of publications printed was 2,348,447, while in 1899, with total appropriations of $185,260, the number of copies of all publications printed was 7,075,975, showing a proportionate excess of at least 2,000,000 copies in the actual output of printed matter in 1899 over 1891.

FARMERS' BULLETINS.

Of the total number of copies of Farmers' Bulletins printed (2,437,000), Senators, Representatives, and Delegates in Congress took 1,101,985—considerably less than last year and the year previous. Under the law, when Senators, Representatives, and Delegates do not avail themselves of the entire number of Farmers' Bulletins allotted to them, the same revert to the Department for miscellaneous distribution or for satisfying further Congressional orders. I am therefore able, for the current year, to increase the quota of Farmers' Bulletins allotted to Members of Congress from 4,000 to 5,000 copies. During the year 22 new Farmers' Bulletins were issued and 154 of those heretofore published were reprinted. Most of the bulletins of this series are of permanent value, and are therefore suitable for continuous distribution. It is my intention to still further increase this series by adding to it bulletins upon such subjects as the people seem to require information, and to give the same the widest possible distribution. The total number of Farmers' Bulletins issued since the series was inaugurated up to the close of the fiscal year ending June 30, 1899, was just 100, and the total number of copies printed was 11,270,500, of which Senators, Representatives, and Delegates in Congress have received and distributed 6,851,752.

MISCELLANEOUS PUBLICATIONS.

Of publications other than Farmers' Bulletins, 427 were prepared in the various Bureaus, Divisions, and Offices of the Department. As usual, these bulletins, many of them scientific or technical in character, have been distributed as judiciously as possible, the effort being to place them in the hands of those only to whom they will be of special interest and value, and to prevent waste or duplication. I regret that under the law the editions of some of the most valuable of these bulletins are restricted to 1,000 copies, so that the important information they contain can not be given the wide dissemination it should receive. It is earnestly hoped that this unwise restriction may be speedily removed, so that there may be no obstacle to the distribution of publications for which an urgent demand exists. It is interesting to note in this connection that during the year the Superintendent of Documents sold 18,750 copies of the publications of this Department, which had been turned over to him under the law, constituting 70 per cent of all the public documents disposed of by him during that time, thus indicating that there is a considerable number of persons to whom the small price affixed by the Public Printer is no obstacle to obtaining publications in which they are interested.

THE YEARBOOK FOR 1899.

The Yearbook for 1899 is now in course of preparation and is modeled in accordance with the plan suggested in my last report. It will contain a résumé of the achievements in the United States in every branch of science related to agriculture during the nineteenth century, and it is hoped that Congress will see the propriety of ordering an extra number, say 20,000, for distribution at the Paris Exposition in 1900. In connection with our agricultural exhibit, the distribution of special-bound copies of this publication would serve the useful purpose of acquainting foreign countries with the achievements in agriculture in the United States.

AN EVIDENCE OF THE DEPARTMENT'S USEFULNESS.

This steady and rapid growth in the publication work is a most gratifying indication of the success of the Department in fulfilling that section of the organic law creating it which makes it an essential part of its duty to diffuse information among the people on subjects relating to agriculture. Brief, popular pamphlets continue to afford the most acceptable means of widely disseminating the results of the Department's investigations, while the scientific and technical publications, still considered as standard works of reference and authority by scientists both in this country and abroad, are accorded their deserved prominence in libraries and institutions of learning. The people have a right to look to this Department as the highest authority on every subject connected with agriculture, and the number of publications issued which are designed to supply the information requested, as well as the very wide distribution given to them, is a most satisfactory indication that the Department is occupying the place intended for it in the machinery of the General Government.

THE LIBRARY.

GROWTH OF THE LIBRARY.

Additions to the Library during the past year have numbered about 4,000 volumes, including some very rare works and scarce sets of periodicals. The periodical list of the Library is growing very fast, owing to the efforts made to increase our exchange lists with publishing scientists and the officials of various countries. There are currently received by the Library at the present time nearly 2,500 periodical publications, more than 1,800 being obtained by way of exchange and gift. The care of this mass of literature is becoming a more and more serious problem in the limited room at the disposal of the Library.

CATALOGUES.

The card catalogue during the four and a half years since its inception has grown enormously. There are now more than 50,000 cards in the catalogue, covering, in author and subject entries, more than two-thirds of the books in the Library. The publication of a catalogue of books on forestry has shown that the collection on this subject is extremely full, having undoubtedly more than three times the extent of any other similar collection in this country. Catalogues of the books on botany and chemistry are well advanced and will probably be published before the end of next year. There is also in progress a complete author and subject catalogue of the publications of the Department of Agriculture since 1839, with such analytical entries as will bring out the subjects of separate papers in publications like the Yearbook and the Farmers' Bulletins.

DEMAND FOR THE PUBLICATIONS OF THE DEPARTMENT.

The demand for the publications of the Department is increasing at home and abroad very rapidly. They are attracting great attention among the learned men of foreign countries. We receive in exchange for them a large proportion of the valuable agricultural publications of all countries, and every attempt is made by correspondence to increase the material obtained in this way.

DIVISION OF ACCOUNTS AND DISBURSEMENTS.

For the fiscal year ended June 30, 1899, Congress appropriated for the Department of Agriculture $2,829,702. By the same act $720,000 was provided for the 48 agricultural experiment stations. The total expenditures for the year amounted to $2,797,173.49. The unexpended balances were covered into the Treasury.

SECTION OF FOREIGN MARKETS.

INQUIRIES REGARDING FOREIGN TRADE.

Our heavy foreign trade within late years has attracted much attention, both at home and abroad. Numerous inquiries have been received regarding the commercial opportunities offered by the former Spanish possessions. No authority has been given to this Department to get exact information regarding trade facilities in Puerto Rico, Cuba, and the Philippine Islands. The Section of Foreign Markets, has, however, collated and published everything available regarding the trade of those islands. Frequent inquiry comes regarding trade in China and Russia, which seem to offer great commercial possibilities in the immediate future. There is a dearth of reliable information regarding both these countries.

REPORT ON THE TRADE OF THE PHILIPPINE ISLANDS.

The report by this Section on the trade of the Philippine Islands required an unusual amount of research. It was found that the statistics from Spanish sources were meager and gave a very inadequate idea of the commerce that belonged to these islands. The Section has also printed a report dealing with the agricultural resources of the islands, especially plant products, to meet the great demand for information on this subject. The report contained a general description of the most important Philippine cereals, vegetables, roots, fibers, dye plants, etc., supplemented by statistics of production, price, and exportation.

AGRICULTURAL EXPORTS AND IMPORTS.

The record for 1898 shows that our agricultural exports were decidedly the largest in the history of the country. Their total value reached $858,507,942. Among the exports that showed the largest gains were wheat and wheat flour, corn, oats, rye, bacon, lard, hams, cotton-seed oil, and oil cake. It was found that there was a falling off in the agricultural imports, the total value being $314,291,769, which was $86,579,672 less than the year previous. The decline in agricultural imports for 1898 amounted to 22 per cent. Sugar and wool were the principal factors that marked this falling off.

STUDY OF DANISH IMPORTS FROM THE UNITED STATES.

A study of Danish imports from the United States shows that that country was importing in considerable quantities some of the articles that enter most extensively into its export trade—butter and bacon, for example. The Danes, having established a profitable market for butter and bacon abroad, sell their own and buy from us. It is not well established, however, that they do not import American farm products for reexport under local names. We know that American bacon is heavily imported into Ireland and sold in England as Irish bacon. We have also information from agents abroad that the thrifty people of that country (Ireland) import well-bred American horses and sell them to the English, in many cases, as Irish hunters.

American wheat flour is competing in Denmark with the home product. During the fiscal year 1898 our shipments of this article to Denmark amounted to 61,019 barrels, more than 20,000 barrels in excess of the largest shipments previously sent. The Danish bakers find that the American flour is as good as the best Hungarian, although less expensive, and it is being generally substituted for the latter. The milling industry of Denmark is declining. Every indication points to an increase in the amount of flour imported from the United States.

The American farmer is furnishing cow feed to the Danes. They imported 16,874,943 bushels of indian corn in 1898. This, in addition to the more nitrogenous mill feeds imported, enables the Danish farmers to supply the British markets with some thirty-three million dollars' worth of dairy products every year. The growth of the dairy industry in the United States indicates that before many years the American farmer will feed his cow feed at home and sell the product of his skill in foreign markets. The Danes bought 55,958,939 pounds of oil cake from the United States in 1897, and in 1898 they bought

155,121,048 pounds. The American farmer can not afford to export the nitrogenous by-products of the mills, as the soil that grows them is regularly reduced by taking them from the farm.

In this connection, it may be interesting to state that butter made in Denmark from these American imports is peculiarly well adapted to the markets of tropical countries. The butter has a higher melting point than butter made from the wider carbonaceous ration generally used in the United States. We raise linseed in the United States to get the oil with which to make paint for our buildings, but have not learned that the nitrogenous by-product is of the first importance in feeding live stock, especially the dairy cow. We are also shipping considerable quantities of bran, and the trade is growing in these nitrogenous exports.

The Danish farmer is enabled to furnish the markets with the finest possible product, and at the same time maintain the fertility of his acres. The Danes are reclaiming waste lands through the use of fertilizers resulting from the purchase of our nitrogenous by-products. We are reducing our lands to sterility by selling these products. It is the duty of this Department to assist the farmers of the United States to find markets for all their surplus products. It is also our duty to warn them of the consequences of exporting stock feed to foreign countries. The Danes have developed a heavy export trade in some of the products of the farm, and the secret of their success lies in the great pains they take to cater to the particular requirements of the foreign consumer and the care they exercise to maintain the uniform high standard of their products.

Not only is every precaution taken to prevent the exportation of inferior or damaged articles, but sufficient attention is always devoted to the packing and methods of shipment to insure arrival in good condition of the articles exported. We exercise no supervision over the shipments of American dairy products. The foreign buyer can depend upon the character of the consignments received from the Danes, but unscrupulous traders in the United States devote their utmost energies to imitations of our best dairy products. Some years ago we had an excellent market in Great Britain for our cheese, whereupon a spurious article was exported that destroyed the good name of American cheese. This is being done now with regard to American butter.

Copenhagen is the natural distributing center for the trade of the Baltic Sea, and it has established a free port for the transshipment of merchandise billed to other destinations. The amount of American merchandise distributed through the Baltic region is increasing very rapidly. During the fiscal year 1898 our direct shipments to these Scandinavian countries amounted in value to more than $25,000,000. Although agricultural products form a large part of this item and show a material gain for the past decade, the principal increase has occurred in our shipments of manufactured wares, such as machinery, tools, utensils, etc.

Ten years ago the annual value of the exports of manufactured articles from the United States to the Baltic countries did not exceed $3,000,000. It now amounts to $10,000,000. Meanwhile the annual value of our agricultural exports to the same region has risen from less than $10,000,000 at the beginning of the decade to about $15,000,000 at its close. As long as the United States produces the cheapest cow feed in the world for export, the market for agricultural products will grow in the Baltic countries. Our best opportunity in this region, however, lies in the development of a wider demand for our manufactures, of which the prospect is excellent. Transshipment at Copenhagen for other Baltic ports is a blunder on our part. American ships should take goods to their destination under the American flag in all parts of the world.

WORK OF THE SECTION IN FURNISHING INFORMATION.

One of the most useful features of the work performed by the Section of Foreign Markets is the furnishing of information to American citizens all over the country regarding these lines of industry. These inquiries are very extensive. Pamphlets have been prepared, and others will be, covering the information in most general demand, and at a time when the products of our fields and factories are so much beyond the requirements of home markets, the work of this Section is peculiarly valuable.

BUREAU OF ANIMAL INDUSTRY.

NUMBER OF ANIMAL INSPECTIONS AND COST.

The report of the chief of the Bureau of Animal Industry for the last year shows that the work carried on by the Bureau is increasing rapidly from year to year, and is becoming more and more an important factor in the economy of animal production and in the exportation of animal products. Meat inspection was conducted during the last year at 138 abattoirs in forty-one cities. The total number of antemortem inspections of animals was 53,223,176, of which 34,405,973 were for official abattoirs and 18,817,203 for abattoirs in other cities and for miscellaneous buyers. The number rejected upon this examination was 156,539. The growth of this feature of the work is shown by the fact that in 1892 the total antemortem inspections for official abattoirs was only 3,809,459. The total number of postmortem inspections was 34,163,155. The cost of this inspection was $465,709.23. The cost per head on antemortem inspection was 0.88 cent; in 1892 the cost per head was 4.75 cents, and only once was it less (0.8 cent).

The number of hog carcasses examined microscopically was 2,227,740.

Of this number, 2,160,230 were free from all appearance of trichinæ and 25,913 contained only trichinæ-like bodies, while 41,597, or 1.87 per cent, contained living trichinæ. The exports of this pork to countries requiring inspection amounted to 108,928,195 pounds, while only 70,046 pounds went to countries not requiring inspection. The cost of this work was $198,355.14, or 8.9 cents for each carcass, and 0.182 cent for each pound exported.

There were inspected for export 436,595 American and 67,688 Canadian animals. The number of inspections of vessels for carrying export animals was 852. Of the cattle exported to Great Britain, the losses were but 0.31 per cent; of sheep, 1.54 per cent; of horses, 1.11 per cent.

The expense of inspection of animals for export, the supervision of the movement of Southern cattle, and the inspection of animals imported from Mexico amounted to $107,023.31. It is estimated that the cost per head of inspecting cattle and sheep for export averaged 13 cents. During the quarantine season of 1898 there were unloaded at stock yards north of the infected area 911,455 quarantine cattle, and there were inspected in the noninfected area of Texas 236,369 cattle for shipment into other States for grazing. The imports from Mexico requiring inspection at the boundary line were 79,908 cattle, 1,254 sheep, 64 hogs, and 121 goats. The imports from Canada, not subject to quarantine, were 90,468 cattle, 172,985 sheep, and 1,769 horses. Some of these were for breeding, but the large majority were for feeding purposes. The total number of animals received at the ports of import was 2,463.

All of this work was done to prevent the spread of disease among the animals of the United States, to protect consumers from diseased meats, to secure the arrival of our animal products in foreign markets in good condition, and to maintain the reputation of those products at home and abroad.

LOSS FROM BLACKLEG.

According to the latest report, it is estimated that the annual loss of cattle from the disease known as blackleg, or symptomatic anthrax, in the districts principally affected has ranged from 5 to 35 per cent. The Bureau of Animal Industry has been for some time distributing a vaccine for the prevention of this disease, and this, it is estimated, has reduced the loss to 0.54 per cent among the animals treated. As it is known that a large percentage of this loss was due to careless operators, it is believed that with more care in the use of the vaccine future investigations will show a still further reduction. Vaccine is still being sent out, and during the fiscal year 545,289 doses were distributed. The indications are that the contagion gradually dies out where systematic inoculations are practiced, and it was with the hope of eradicating the disease from many sections that the preparation of vaccine was undertaken.

TEXAS-FEVER INVESTIGATIONS.

The experiments of the Bureau demonstrated that Northern cattle might be made immune from Texas fever by inoculating them with the blood of immune animals. This has recently been adopted and practiced with most satisfactory results by some of the experiment stations. The practical application of this discovery is of great importance both to the breeders of improved stock in the more Northern States and to the cattle raisers of the infected district, as it permits the improvement of Southern herds without the discouraging losses that have heretofore always occurred.

Experiments have been continued with a view of obtaining a mixture in which cattle from the Texas fever districts may be dipped for the destruction of the ticks which spread the disease, and which at the same time will not injure the cattle. This effort has not been entirely successful, but the progress of the work heretofore leads to the hope that such a mixture may be found. The difficulty in finding such a mixture is plain to those who know how tenacious of life is the tick which is the carrier of this disease.

Investigations in Puerto Rico show that the cattle tick is prevalent there, but the ticks which were brought from there and placed on cattle in the United States failed to produce Texas fever. Whether this result was accidental or whether these ticks are without infectious properties is a question of great importance. If further investigations show that the Puerto Rican tick is free from the Pyrosoma, the true contagion of the disease, and that the cattle of Puerto Rico are susceptible, the introduction of a single animal bearing the Pyrosoma might convert these comparatively harmless parasites into the most deadly scourges of the bovine race. This subject will receive further attention during the current year.

TREATMENT FOR HOG CHOLERA.

The preparation of serum for treating hog cholera and swine plague has been on a very much larger scale than last year, and the results are exceedingly satisfactory. The diseased herds in four counties of Iowa have been under treatment, the results showing a saving of from 75 to 80 per cent of the animals injected, though the final reports are not all received at this writing. It is evident, however, that this method of treatment is far in advance of any other heretofore tried.

SHEEP SCAB.

For many years the parasitic disease of sheep popularly called scab has been quite prevalent, especially among the flocks of some of the

Western States and Territories. Diseased sheep have been shipped from one State to another in violation of the law, and the stock yards and stock cars have been almost continually infected. The result of this condition has been that sheep could not be purchased for feeding purposes in any of the markets of the country without danger of bringing to the farm with them the contagion of this disease.

Sheep scab has been one of the greatest evils which the sheep industry has had to contend with. Not only does it always damage and often destroy the fleece, but it reduces the strength and condition of the affected animals so much that they fall an easy prey to internal parasites or succumb to unfavorable conditions of food and surroundings. Congress has specifically referred to this disease in the appropriation act as one of the diseases which the Department is authorized to control by sanitary regulations.

The first step taken by the Department looking to the limitation and control of this disease was the issuance of a circular letter notifying transportation companies and shippers of the existence of the contagion, and pointing out the prohibition of shipment and the penalty provided by law. Subsequent to this an order was issued that diseased sheep discovered by the inspectors in the channels of interstate commerce should be detained and dipped before going on to destination; also, that sheep purchased in infected yards for feeding should be dipped before they were allowed to go to farms. The effect of these orders was to protect the purchasers of store sheep and to lessen the number of diseased animals sent to market. It was found, however, that some of the dips used by the stock yards, companies, and owners of sheep were not efficacious under the conditions which obtain in this service, and that others were so severe or poisonous as to be dangerous. An order has, consequently, been issued specifying the kinds of dips which would be recognized and the manner in which these should be prepared and applied.

The effect of these measures has been extremely satisfactory, and the number of diseased shipments received at the principal stock yards have been very materially decreased. This has been accomplished without putting the shippers of healthy sheep to any inconvenience or expense unless the animals were going to farms from infected stock yards. The inconvenience of detention and the expense of dipping have had an excellent effect in lessening the number of diseased sheep sent to market, and has led to active efforts everywhere to cure them on the farm or ranch before shipping. The indications are at this writing that it will soon be possible to make the stock cars, the central stock yards, and other channels of interstate commerce safe and free from infection, in which case store sheep could be purchased in the markets without danger of infection, and only diseased sheep would come under the restrictions.

EXPERIMENTAL EXPORTS OF DAIRY PRODUCTS.

The experimental exports of dairy products made during the last two years and now in progress under special provision of law have produced marked results. But these are not satisfactory in all respects and the reputation gained needs to be protected by authority from Congress for some system of export inspection. The new markets opening for our dairy products require a guaranty of the purity and quality of butter and cheese sent from the United States, such as is given by other Governments, and especially Canada.

Not long ago this country supplied and practically controlled the cheese market of Great Britain. In some years we sent to England nearly 150,000,000 pounds, or two-thirds of our entire cheese product. But as no system of export inspection existed to guard the established reputation, unscrupulous merchants exported great quantities of inferior, adulterated, and counterfeit cheese, until the reputation of States cheese was destroyed in England, and that market lost to us. Canada, on the other hand, adopted a system of government control, was enabled to guarantee all cheese exported as pure and of standard quality, and thus secured, and still holds, the desirable British cheese trade which this country lost. We have recovered a little, but only a little, of the lost ground. The best cheese now exported from this country goes through Montreal, seeking the same avenues and the good company of Canadian cheese, finding a market virtually as a part of that product.

The same unfortunate result seems likely to follow the efforts to export fine creamery butter to Great Britain unless measures are promptly taken to avoid it. An active demand has arisen for this butter especially in the northern counties of England, supplied from Manchester, largely through the experimental efforts of this Department. During the summer of 1899 an exceptional scarcity of European butter caused very high prices, and British merchants sent large orders to New York. In the month of August our butter exports were six times as great as for the same month a year ago. This new and profitable demand for fine creamery butter had scarcely begun, however, before large quantities of an inferior article and also of imitation creamery, "process," or renovated butter, began to appear among the exports.

This article, which is a more dangerous and damaging counterfeit of fresh creamery butter than straight oleomargarine, was sent to New York by the carload for export. In at least one instance parties had renovated butter put up in the West, in the style of package adopted by this Department in its recent export trials to England, and this went abroad labeled "Finest American creamery butter." The effect of this upon future butter trade with Great Britain will probably be like that which followed the export of so much unidentified filled cheese. Already English merchants, who have been trying to introduce States creamery butter among their customers, have written to this Department complaining of the deception practiced upon them.

Out of six large lots of butter received by one firm at Manchester from the United States, all represented as "extra creamery" goods, five were rejected as being far inferior to the quality represented—apparently only poor imitations. Meanwhile Canada is forging ahead, with government supervision and guaranty to assist, and securing for its creamery butter a firm hold in the British markets. The lack of some protection by Government certification of exports from this country is already causing butter shipments by way of Canada, as in the case of cheese, previously mentioned. British merchants state that some of the best States creamery butter they have lately seen (as shown by makers' marks) has been among lots received from Canada.

I recommend, as a simple and effective remedy for these growing evils and obstacles in our export trade, that the existing system of Government inspection and certification of meats and meat products for export be extended by law so as to include butter, cheese, and condensed milk and cream. With slight modifications the organized force and regulations which now give protection and standing to our meat exports may be made to cover the new work proposed. The services of an inspector who is an expert in butter and cheese would be necessary for parts of the year at three or four exporting points; but until these exports increase New York would be the only place at which such an inspector would have to be continuously employed.

If such inspection and certification is authorized by Congress, the pure and unadulterated dairy products of the United States that are of a quality entitling them to official indorsement can be given a position in foreign markets which they can not otherwise secure, and which will enable them to compete successfully with like products from any other country.

This inspection of dairy products for export has been indorsed by nearly all the national and State dairy organizations in this country and has met with decided approval by commercial bodies and by individual exporters wherever it has been duly considered.

DIVISION OF STATISTICS.

INVESTIGATIONS DURING THE YEAR.

The condition of the agricultural industry, as indicated by the area of land devoted to the cultivation of the principal products of the soil; the actual volume of production and the value of particular crops, both on the farm and in the principal markets; the cost of production per acre and per unit of quantity and the cost of transportation; the number and value of farm animals and the losses annually resulting from disease and exposure; the volume, condition, and prospects, according to the season of the year, of such of the crops of foreign countries as compete with those of the United States in the world's markets, have constituted the field of investigation in which this Division has been engaged during the past year.

STATISTICAL REPORT.

Of the regular periodical reports of the Division there has been printed a total of 1,621,700 copies. These reports cover that general work of the Division which is continuous in its operation and which has constituted for a generation or more the only source of information available to the farmer that has been comprehensive, prompt, and unbiased.

THE CROP-REPORTING SYSTEM.

No change of essential or far-reaching importance has been made during the year in the methods of collecting agricultural statistics, but there is a marked improvement in all the different agencies employed, the monthly reports being more complete, giving evidence of greater care in their preparation, and generally displaying a more intelligent conception of the requirements of the Department on the part of its correspondents.

At the end of the fiscal year the organization included 41 salaried State statistical agents, with 8,730 correspondents, upon whose reports their monthly statements were mainly based; 2,627 county correspondents, with 7,881 aids and 36,426 township correspondents reporting each for his own immediate neighborhood. From this large body of persons—selected with great care, not only as to their geographic distribution, but also as to their qualifications for the performance of the duties required of them—reports have been received monthly, and at the close of the calendar year a select body of farmers, numbering about 90,000, reported upon the crops of their own individual farms. The Department is indebted to numerous transportation companies for monthly returns of cotton carried over their respective lines, information which has been of the greatest value in the making up of its final returns on the production of cotton.

No important change in the crop-reporting system will be recommended until the approaching federal census shall have furnished the Department with a new and definite statistical basis as to the distribution of crop areas. The Department's system is based, in the main, upon a periodic comparison of the acreage devoted to particular crops with that so used in the preceding year, and it is consequently not only impossible to make any increase, during the closing years of an intercensal period, in the number of products reported upon, but it is difficult, even as regards those which are reported upon, to keep exact step with a fluctuating acreage and a constantly varying production when the cumulative effect of even a small annual error in a report based on percentages may reach large proportions.

A PUBLICATION FOR CROP CORRESPONDENTS.

Much of the improvement so gratifyingly in evidence in the reports of correspondents is doubtless attributable to the issue of a new monthly publication known as "The Crop Reporter," designed for the exclusive use of the Department's crop correspondents. The necessity of compressing into very small space the instructions printed upon the monthly reports, the marked localization of the area of production in the case of not a few of the crops reported upon, and the general lack of uniformity in the agricultural methods and conditions obtaining in the different sections of the country have alike suggested the employment of some agency by which correspondents could be more fully instructed as to their duties and the instructions given them be better adapted to their various needs.

Such an agency has been found in the new publication, which has been received with many expressions of satisfaction by correspondents in every part of the country. By anticipating their needs, interesting them in their work, making intelligible to them the relation which, as individual correspondents, they bear to one of the most important branches of the work of the Department, and putting into their possession, without trespassing upon the province of the agricultural journals, a great variety of information calculated to make them better judges of agricultural conditions, and consequently more valuable correspondents to the Department, "The Crop Reporter" has been the means of greatly improving the crop-reporting service, while incidentally reducing the enormous correspondence of the Division by nearly one-half.

SEED DISTRIBUTION.

COST OF DISTRIBUTION AND FAVORABLE REPORTS RECEIVED.

An appropriation of \$130,000 was made by Congress for the purchase and distribution of valuable seeds, etc., during the year 1899. Of this sum, there was expended for the purchase of seeds for distribution through Members of Congress \$70,978.36. For rare and valuable foreign seeds distributed by the Section of Seed and Plant Introduction, under the Division of Botany, \$20,300.92 was expended; for the purchase of sugar-beet seed distributed to experiment stations and individuals, \$2,366; for seeds and bulbs distributed to Members of Congress through the Division of Gardens and Grounds, \$3,400, and for seeds distributed for special investigation by individuals in the several States, \$3,000. There was paid for salaries of employees connected with the seed distribution \$25,912.98, and for miscellaneous supplies in connection with the work, $221.85. There are some outstanding vouchers for freights, etc., not yet adjusted.

The contractor was required to provide a building within the City of Washington in which to pack the seeds, and samples were tested by the Division of Botany for purity and germination. The high quality of the seed now being sent out by the Department is scarcely equaled by any of the distributing agencies of the United States. Of 979 letters received regarding the seed distributed, 972 report favorably upon the quality.

AIM OF THE DEPARTMENT IN THE DISTRIBUTION OF SEED.

The original intention of Congress in providing for the distribution of seed undoubtedly was to do for the producers a class of work they could not do for themselves—to search the various localities of the Old World for seeds and plants, and distribute them in the United States to the several regions where they would be most likely to succeed. The Department at present is endeavoring to bring back the practice, as much as possible, to the original intention of Congress. Quite a large percentage of the $130,000 appropriated is now spent in finding, purchasing, importing, and distributing rare seeds and plants.

The Department is in receipt of letters from seedsmen throughout the country urging the discontinuance of this work, and there is an uneducated sentiment here and there cooperating with the seedsmen along this line, which prompts ill-informed individuals to concur with these representations. I am well satisfied that the introduction and distribution during the last two years of seeds and plants rare or not found at all in the United States has been worth more money to the people of the country than all the expenditures of Congress for seed distribution to date. To the extent to which the distribution by the Department competes with the sales of seedsmen and others distributing precisely the same kinds of seed, with no experimental feature and no intelligent direction regarding the use of the seeds beyond that which is provided by dealers, the practice is questionable. But the furnishing to the people of the United States of sugar-beet seed of the most approved quality, for experimentation, to ascertain where beets can be grown sweet enough to produce our own sugar, is justifiable; the introduction of drought and rust-resisting grains from foreign countries, which are urgently needed by people in the United States who are losing heavily from drought and rust, is justifiable; the rehabilitation of the Western ranges that have been destroyed and in many cases reduced to desert conditions by injudicious grazing, is justifiable; the encouragement of tea growing in the States along the Gulf of Mexico, where labor is as plenty and as idle as anywhere in the world, is justifiable; the inquiry into the several plants that produce rubber, the gathering of the seed of these plants, their germination and preparation for setting out in such localities in the new island possessions of the United States Government as may be best suited for producing the $30,000,000 worth of rubber now purchased from foreign countries, is justifiable; the introduction of the date palm from Tripoli in Arizona, establishing a new industry in that region which may extend to other localities in the same latitude, is justifiable. The introduction of these and many other seeds and plants, entirely beyond the ability of private individuals to compass, in order that such seeds and plants may eventually enter the commercial class and be handled by seedsmen, is the aim of the Department of Agriculture in seed distribution at the present time.

SUGAR BEETS.

During the last three years extensive experimentation has been had in cooperation with most of the States of the Union to ascertain where sugar beets can be produced sufficiently sweet to justify extensive growing and manufacturing. It has been fairly well demonstrated that many States have soil and climate, fuel, water, and limestone admirably adapted for this industry. Thirty-two factories are now in operation and many more in contemplation. There is every indication that the United States will produce its own sugar within a few years. The rich valleys of the mountain and Pacific coast States find sugar making very profitable. It is being demonstrated that the rich cornfields of the Northern States are also admirably adapted to the growth of the sugar beet. This industry will eventually be more profitable where the by-product is fed to the dairy cow and other domestic animals. The Department publishes annually a report setting forth all the facts in relation to this industry and the latest developments of interest to producers.

THE MARKET FOR AMERICAN HORSES.

Within the last two years horses have greatly appreciated in value and exports have rapidly increased. The Department issues annually a revised report, giving horse raisers facts regarding exports, as well as the requirements and demands of foreign countries for horses for different purposes.

DOMESTIC TEA PRODUCTION.

EXPERIMENTS AT SUMMERVILLE, S. C.

An interesting experiment is being conducted at Summerville, S. C., in the production of tea. Three thousand six hundred pounds of dry tea were produced during the past season. Dr. Shepard, a gentleman of education and enterprise, who owns the garden, has overcome the difficulties arising along labor lines by building a schoolhouse for the education of the children of his colored neighbors, where they are taught free of expense, with the understanding that they shall pick his tea when required, at a reasonable rate of wages. This class of labor in the South is very plenty and very idle. The elementary education and habits of industry acquired must have a good effect from every standpoint from which the best interests of these people can be considered. If a new industry of this kind can be introduced into the Gulf States, which will save the people of the United States the many millions of dollars now sent abroad for the purchase of this commodity, and at the same time provide light work for the young people who are now entirely idle, there is a double incentive to make research to the utmost regarding the production of a commodity in such universal use.

INVESTIGATIONS TO BE CONDUCTED.

Congress at its last session appropriated $1,000 to enable the Department to conduct experimentation in tea growing. While the average rainfall at Summerville ranges between 50 and 60 inches, there are times when the rain does not fall for considerable periods. Experimentation is now being arranged for to ascertain whether by irrigation a more continuous growth can be maintained and more frequent picking of the leaves be had. Arrangements are also being made to experiment in the manufacture of green tea without the use of chemicals. The Department of Agriculture has a sufficient number of plants growing in pots to start experimental tea gardens in all the Gulf States from Florida to Texas, and including California. Efforts are being made to induce the experiment stations in those States to cooperate with the Department in conducting these experiments.

Experiments in South Carolina have shown that the production of 200 pounds of dry tea per acre is readily obtainable under favorable conditions, with a probability of double or perhaps treble that amount when the plants have arrived at full bearing. It is desirable to ascertain the limit of productiveness under all the varying conditions of surface, soil, and seed varieties. It is gratifying to note that the yield per acre has steadily advanced, in spite of all hindrances, from 50 to 150 pounds per annum per acre for the whole of the older tea gardens at Summerville within the past few years. The best varieties from all the countries of the Orient are being experimented with, and efforts will be made to add promising new varieties, both by importation and by hybridization. Experimentation of this nature is beyond the capacity of men of moderate means, and I am of opinion that it is entirely justifiable that Congress, through the Department of Agriculture, should assist in demonstrating the probability of raising tea in the United States, for home consumption at least.

It will be necessary as the work progresses to employ professional tea tasters of wide experience to indicate the value of the several varieties being experimented with. A higher valuation per pound may offset a lesser production. Experimentation in shading from the direct rays of the sun is very encouraging. The leaf thus produced was tender, very lustrous, and made a very delicate tea. The means of manufacturing must of necessity be increased, and the testing of new machinery as regards cheapness of work and thoroughness of execution provided for. It is desirable to study carefully the composition of tea made from the same bushes at different times during the picking season, to analyze the product in this country of gardens raised on soil from widely separated sources, and to test the effect on tea of different sorts of manure. This is a large and expensive kind of experimentation, requiring special chemical apparatus and unusual nicety and skill.

LEASING THE PUBLIC LANDS.

CONDITION OF THE RANGES.

I have looked carefully into the condition of the ranges in most of the States west of the Missouri River. The Department of Agriculture has been conducting experiments in most of these States with native and imported grasses through the experiment stations, private individuals, and sometimes directly under the management of its own officers. Injudicious grazing has greatly impaired the capacity of the ranges to produce meats. Careful inquiry shows that in many cases the ranges do not support more than half the meat-bearing animals they did ten years ago. The ranges have been overstocked, the grasses have been eaten bare and pulled out by the roots, and where formerly nutritious grass supported a large number of animals, there is now left nothing but a desert of drifting sand.

The principal reason for this condition of the ranges undoubtedly is that no single individual has an interest in any one part of the public domain. The object of the flock master is to secure all the grass possible, irrespective of the effect it may have on the future condition of the pasture. Thousands of sheep that can not find grazing on the plains are being taken into the innermost recesses of the mountain systems.

LEASING AS A MEANS OF IMPROVEMENT.

It would seem wise to inaugurate a more sensible policy regarding these public grazing lands. They should be rented to individuals in sufficiently large areas and for a sufficiently long time to induce the lessee to give attention to their improvement. The title should remain in the United States, so that the homesteader might have an opportunity, under such conditions as would not interfere with the renting, to make settlement wherever practicable. The rents arising from these leases might very well be given to the States for such uses as they might deem wise, either for educational purposes or for irrigation work. A very considerable amount of money would come every year from these leases, with which the States could begin experimentation in the way of building dams and holding the water against a time of need. My main object in making this recommendation is that the lessee and the Department of Agriculture may enter into cooperative experimentation looking to the improvement of the grazing lands.

EFFORTS TO SECURE PLANTS FOR SEMIARID REGIONS.

There are millions of acres that can not be cultivated in any crops with which we are now familiar. The Department of Agriculture is searching the dry areas of the world for plants that may be successful in furnishing the materials of food to a greater extent than is now practicable on our semiarid regions. The introduction of sorghum, Kafir corn, dry-land alfalfa, the Russian brome grasses, etc., is enabling the farmers of the States west of the Missouri to extend cultivation over lands that did not succeed in corn, or oats, or clover.

ABANDONED FARMS.

My attention has been called to what is known as the abandoned farms of New England. A personal inspection of some of these farms shows that they are not abandoned on account of sterility of soil, but are in many cases capable of affording a good living to industrious farmers, and under more favorable auspices than are farms in some of our newer States, on account of nearness to market, educational institutions, and other desirable environments. The Agrostologist of the Department has visited several of these farms to ascertain in what way help can be given by the introduction of grasses suitable to their various conditions, and the Soil Physicist will study conditions on these farms and indicate which soils may be profitably cultivated and which should be devoted to forestry. The Forester will also visit these localities and determine what varieties of trees are most desirable. The Department will endeavor to have Farmers' Bulletins prepared along these several lines for distribution among the farmers of New England.

TROPICAL IMPORTS.

Our imports of tropical-plant products have a value of about $200,000,000 a year. Nearly all of these could be produced in Puerto Rico, Hawaii, and the Philippines if the best use were made of the agricultural possibilities of these islands, and of American industry, ingenuity, and financial resources. Our tropical-plant imports are four times as great as the total exports of Hawaii, Puerto Rico, and the Philippines. For coffee and sugar we pay an amount exceeding by more than $80,000,000 the agricultural and all other exports of these islands. Omitting sugar and tobacco, our tropical-plant imports still greatly exceed the total agricultural exports of these tropical dependencies. Our imports of oranges, lemons, and cocoanuts have about the same value as the sugar and tobacco exports of Puerto Rico, and could readily be produced on that island.

There are several staple agricultural imports of the United States other than oranges, lemons, and cocoanuts to which attention should especially be called as worthy of consideration for introduction into Puerto Rico, such as vanilla, our imports of which vary in value from $279,755 to $1,013,608 per year; gutta-percha and india rubber, about $30,000,000, and cacao, $5,000,000. The improvement and extension of coffee culture in Puerto Rico is well worth careful investigation and encouragement, since our total coffee imports in 1898 amounted to $65,067,631. There is every reason to believe that a portion of our banana imports, which during the year 1899 reached a value of $5,665,588, may to good advantage be grown in Puerto Rico.

INDIA RUBBER.

IMPORTANCE OF THE TRADE.

The india-rubber trade is of great importance to the United States and has shown a rapid increase during the last few years. For the fiscal year ended June 30, 1890, the total importations of crude rubber amounted to 33,842,374 pounds, valued at $14,854,512, while that of manufactured rubber was valued at $367,647. In the fiscal year 1898 the imports of crude rubber and gutta-percha amounted to 46,055,497 pounds, valued at $25,386,010, while that of manufactured articles and waste or scrap rubber was 9,488,327 pounds, worth $805,951. This shows not only a decided increase in the quantity imported, but also a rapid rise in price. In 1890 about two-thirds of the entire amount imported came from Brazil. In 1898 about three-fifths came from that country.

A recent United States consular report shows that the importations into England for 1898 amounted to 20,026 tons, about half of this being Brazilian. New fine Para rubber was quoted at New York from 66 to 69 cents per pound in 1893, 69 to 71 cents per pound in 1894, 73 to 77 cents in 1895, 74 to 88 cents in 1896, 80 to 87 cents in 1897, and 82 to 83 cents January 1, 1898. A single cargo of rubber, consisting of 1,167 tons, shipped from Para February 23, 1898, was valued at $2,210,000 in United States gold. The exports of rubber from Brazil in 1898 amounted to $38,400,000 gold.

COLLECTION AND TREATMENT AND SOURCES OF SUPPLY.

Rubber is derived from the milky sap of a number of trees and shrubs, all native to the tropical regions of South America and the Old World. There are many plants with milky sap which contain small quantities of rubber, but none are known which produce it in commercial quantities anywhere outside of the Tropics. The methods of collection and treatment of rubber are, in the main, very crude. There is a great deal of waste and considerable deterioration through improper methods of treatment in the field and in transit, and through impurities. The only successful experiments at cultivating rubber plants which have thus far been made were undertaken by the English Government in Ceylon, India, and some of the other tropical colonies. By following the most improved methods of cultivation and by giving the rubber plantations the same careful attention which is devoted to other crops, it appears possible to make this an exceedingly profitable investment.

The larger part of the Brazilian rubber is produced by the Para rubber tree, *Hevea brasiliensis*, which grows naturally in the deep shade of the swampy forests of the Amazon, where the air is fever-laden and the land is unsuited for human habitation. Experiments have been made with this tree in various of the British possessions in the East Indies, but without any marked degree of success, because the tree attains its full development only in the shade of dense tropical jungle lands and not in the solid plantations. Its successful handling appears to lie in the direction of a proper system of forest management. The Central American rubber tree, *Castilloa elastica*, grows only in the dense tropical forests from southern Mexico to northern South America, on rich, well-drained bottom lands along the rivers. This tree has been found to grow luxuriantly under cultivation, but in the experiments thus far tried it develops a bark much thicker than in its native state, and this has been found a decided drawback to the successful drawing of the sap.

The Ceara rubber tree, *Manihot glaziovii*, is a native of one of the driest portions of southern Brazil, where the mean temperature ranges from 77° to 86° F. There are now many plantations of it in India and Ceylon, and it is probable that this tree will be the first to produce an important addition to the natural supply of india rubber. There are fifty or more species of trees, vines, and shrubs which are a commercial source of india rubber and gutta-percha, and the list is annually increasing. Experiments should be tried in the cultivation of every one of them. Gutta-percha is derived almost entirely from the tree *Isonandra gutta*, a native of the islands of the Malayan Archipelago. The careless methods of the collectors have resulted in killing off most of the plants from which this substance is derived, so that a serious shortage has occurred during the last few years. The feasibility of cultivating this plant in the Philippines should be very carefully investigated.

TURKESTAN ALFALFA.

The unusually severe winter of 1898–99 killed off probably half of the alfalfa of western Kansas, Nebraska, Colorado, and Wyoming, and many fields in the central prairie States to the eastward were badly damaged, but the Turkestan alfalfa grown in the States mentioned was not affected. At the Wyoming experiment station a plat of Turkestan alfalfa was exposed for two weeks without injury to a daily temperature of —35° F., the lowest point reached being —45°. In California it was subjected without damage to a drought which seriously injured ordinary alfalfa. In view of the notable success of this plant in withstanding drought and cold, it has been decided to purchase a large amount of seed grown in America from our imported stock and to distribute it widely over the arid West until it has been thoroughly tested under all the different climatic and soil conditions existing in that region. From the results already secured, it is believed that this one introduction will add millions of dollars to the annual hay product of the United States.

INTRODUCTION OF IMPROVED RICE.

About fifteen years ago the enterprising farmers of southwestern Louisiana began to adapt modern machinery to use in their rice fields, and within a decade they had replaced the antique implements of the hand laborer by the gang plow, disk harrow, drill, and broadcast seeder; they had insured sufficient water by the construction of irrigation canals; and, finally, they had adapted the twine binder of Northern wheat fields to the cutting of rice. So far as methods were concerned, they had created a new system of rice culture which greatly reduced the cost of rice production. It was discovered, however, that sufficient attention had not been paid to the question of varieties. The Louisiana rice, when milled, gave a high percentage of broken grains, and much of it brought, therefore, only a second-class price.

To remedy this difficulty the Department of Agriculture undertook to secure a productive rice of high milling quality. This it has succeeded in doing by importing, after a careful search in Japan, a quantity of Kiushu rice. In yield this rice has proved a distinct success, and if, as is expected, it maintains in Louisiana the high milling average that it possessed in Japan, hundreds of thousands of dollars will be added to the yearly profits of Louisiana rice growers.

In this connection, it may be said that flattering reports have been received about many of the other introductions of the Department, and from time to time, when these reports are amply substantiated, due commendation of these crops will be made to the agricultural public.

NATIVE DRUGS.

The collection of native drug plants in the United States, considered from a purely financial standpoint, aside from medical and humanitarian aspects, involves the expenditure of millions of dollars annually. The commercial extermination of some of the most useful species is already threatened, and doubtless others would be found in the same condition were the facts known. The price of one native plant, ginseng, our exports of which average more than half a million dollars annually, has more than quadrupled in the past thirty years, so that its cultivation, as urged four years ago by this Department, has now become profitable. It is clear from this and many similar cases that the native drug industry is capable of either decline or improvement, according to the way in which we handle it.

The Pan-American Medical Congress has recently submitted to me a proposition to cooperate with this Department in a technical and statistical investigation and classification of our native drug plants. By accepting this proposal we shall secure, in a research of which we have long felt the need, the cordial assistance and support of an influential association of learned physicians; we shall encourage each of the other American nations, all of which are represented in the Pan-American Medical Congress, to proceed with a similar investigation of their own medical flora; we shall furnish a basis for the remunerative employment of much land and many people, and we shall stimulate the great and growing trade in drugs between the countries of North America and South America. I urge the appropriation of $10,000 to enable this Department to cooperate in this investigation.

HEMP.

Our imports of hemp fiber for the past five years have averaged in value $678,475 annually, coming chiefly from Italy and southern Russia. This hemp is worth about 7 cents per pound and is used principally in the manufacture of carpet warps. In addition, we import an unknown but doubtless large amount of manufactured hemp in the form of the cheaper grades of linen. The domestic product of hemp reported by the last census, at a valuation of 3 cents per pound, was worth $690,660 and was grown chiefly in Kentucky. This hemp is used principally in place of jute butts for cordage purposes. The Kentucky hemp producers grow a short plant in small areas with shallow plowing and little or no fertilizing. The crop is reaped and broken by hand, and the fiber is extracted by the process of dew retting. In addition to these heavy charges, an annual rental, averaging probably $10 per acre, is ordinarily paid for the land. There is a reasonable prospect of establishing an extensive hemp industry in the United States on new lines, involving the use of either a taller variety or two crops of the short variety, growing the crop on large areas of cheap land, plowing deep, putting on the necessary fertilizers, reaping and breaking by machinery, and using the process of water retting.

EGYPTIAN COTTON.

The importation of cotton from Egypt steadily increased from less than 200,000 pounds in 1884 to more than 43,000,000 pounds in 1896. Since the latter date, the direct importations from Egypt have fallen off slightly, but the prices have had an upward tendency, and the demand for this staple remains good at from 4 to 6 cents higher than the price of ordinary American upland cotton. Our annual import of cotton from Egypt for the past three years has averaged in value $3,738,338. The Egyptian cotton has a very fine silky fiber, generally shorter than that of sea island but longer than that of upland varieties. It is used in the manufacture of fine yarns for the finer qualities of hosiery and knit goods. It does not come into direct competition with our upland cotton, the fiber of which is too coarse for the finer yarns. Some attempts have been made to grow Egyptian cotton in this country, and in 1894 the Department imported and distributed a stock of Egyptian seeds. The experiments with these have shown promising results, but there is need of further trial to determine the exact conditions under which this cotton can be grown to best advantage. There is good ground for hope that with proper management the industry may become well established in the United States.

NEW LABORATORY BUILDINGS.

The Department of Agriculture is now conducting all of its laboratory work in rented buildings located outside of the Department grounds. These buildings are for the most part mere makeshifts, consisting of dwelling houses remodeled to permit laboratory work. Some of them are overcrowded and none are fireproof. There are five of these buildings which, with rent and other expenses, cost the Department about $10,000 a year. The work carried on by the laboratories is of the highest importance, including the investigations of the Bureau of Animal Industry, the Division of Chemistry, the Division of Vegetable Physiology and Pathology, the Division of Soils, and the Division of Botany. Much of the material now in use by these branches of the Department, as well as that being constantly accumulated by them, is of great value, and it would be impossible to replace it in case of loss by fire. It is absolutely necessary that better facilities be secured for this scientific work, either by the rent of additional buildings or by the erection of a Government building.

As best adapted to our necessities, plans have been prepared for suitable buildings to be erected upon the Department grounds. The plans show structures which are fireproof throughout, and which are arranged so that the several lines of work can be kept as distinct as may be required by their nature, and at the same time the buildings be heated, lighted, and ventilated from one central plant. The several laboratories are now occupying, approximately, 35,000 square feet of floor space, and the new buildings provide about 10 per cent increase over this to allow for future growth. Careful estimates show that the buildings as planned will cost, approximately, $200,000. I therefore earnestly recommend that this amount be appropriated, as it will not only be a saving of money to the Government, but will at the same time furnish facilities commensurate with the importance of the work

A PROPOSED ARBORETUM.

One of the needs of the Department is an arboretum in which can be brought together for study all the trees that will grow in the climate of Washington, D.C. The need of such an establishment was felt early in the history of the Capital, and was brought forward more than fifty years ago among the various plans proposed for the use of the Smithson bequest, which was finally devoted to the founding of the present Smithsonian Institution. In the report of the building committee of that institution for 1850 the following statement occurs:

> Mr. Downing, the well-known writer on rural architecture, at the request of the President, is now preparing a plan for converting the whole Mall, including the Smithsonian grounds, into an extended landscape garden, to be traversed in different directions by graveled walks and carriage drives and planted with specimens, properly labeled, of all the varieties of trees and shrubs which will flourish in this climate.

This admirable plan, apparently from lack of financial support from Congress, was never systematically prosecuted, and the plantings at first made were so neglected that the nurse trees crowded out and killed most of the valuable sorts, and even the nurse trees themselves are now being rapidly broken down and destroyed by storms, disease, and decay. When the grounds of the Department of Agriculture were laid out in 1868, Mr. William Saunders, then, as now, Horticulturist of the Department, established a small arboretum commensurate with the size of the grounds. An arboretum in this climate, however, requires an area of several hundred acres. The time has come when the economic needs of the Department and the education and pleasure of the people demand a rich collection of trees planted so as to secure the best effects of landscape art, furnishing complete material for the investigations of the Department of Agriculture, and so managed as to be a perennial means of botanical education. We are now engaged in introducing useful trees from all parts of the world, such as those producing fruits, dyes, nuts, oils, and tans, those useful for ornamental purposes, and especially those promising shade, shelter, and fuel in the arid region. At the present time we have no central place in which to plant and maintain a series of these trees for study and propagation. The importations must be sent out as fast as they are received, without an opportunity for our investigators to make any observations on their behavior under cultivation, and, in the case of small and valuable importations, subjecting the whole stock to the possibility of total loss. In view of these conditions, I wish to bring to the attention of Congress the importance of placing at the disposal of this Department an area of suitable size and situation for a comprehensive arboretum. In order to give a specific basis for consideration of this project, I suggest that the area known as the Mall be set aside for this purpose.

AGRICULTURAL EDUCATION.

NECESSITY OF AGRICULTURAL TEACHING IN INSTITUTIONS OF LEARNING.

The great prosperity of the country at the present time has resulted, among other things, in a largely increased attendance upon our universities, colleges, and other institutions of learning. When we consider that half the people of the United States are occupied in producing from the soil directly; that about three-fourths of our exports to foreign countries come from the soil, and that the $600,000,000 balance of trade coming to the United States during each of the last two fiscal years have been, to a great extent, the price of farm products, it is somewhat remarkable that so very little attention is given to the education of half the people of the nation and their preparation for their future life work.

The beautiful valleys of the mountain and Pacific-coast States are being injured to a considerable extent by the injudicious use of irrigating waters. The pasture lands of the public domain west of the Missouri River are being rapidly destroyed by injudicious grazing. The wheat-growing area of the country, where crops are grown continuously, are refusing to yield as they did when first brought under cultivation; and from the Dakotas to the Pacific we find systems of fallowing in operation and crops of wheat being taken once in two years, indicating the rapid destruction of the plant food in the soil.

SCIENTIFIC TRAINING IN THE DEPARTMENT.

The people cry aloud to this Department for help. We have gone repeatedly but in vain to the Civil Service Commission and had them advertise throughout the country for soil physicists in order that we might cooperate with the people regarding the deterioration of their soils. All the older sections of the United States have injured their soils by injudicious management. A knowledge of plants—their life history, the diseases to which they are subject, their relations to the soil, the climate, and food necessary to their best development—is so scarce among us that plant physiologists and pathologists can not be found by advertising for them.

Animal husbandry is very little understood, and in most of the educational institutions of the country sufficient instruction is not being given to have it better understood, yet from this source we make our most profitable sales to foreign countries. The Biological Survey and other Divisions have also to train the men to do their work. When the Department requires the assistance of men educated along these lines it is necessary to educate them in its own scientific Divisions, under the direction of its own scientists. When it has trained such men until they become expert and stand at the head of their specialties in the United States (and in many cases in the world), then wealthy institutions take them away by offering higher salaries, interfering with the work of the Department, along the lines mentioned, which is so necessary to the producers of the United States.

REGISTER OF GRADUATES OF LAND-GRANT COLLEGES.

To meet some of these difficulties and avoid in future their frequent recurrence, I have arranged with the Civil Service Commission to make a register of the graduates of the land-grant colleges of the United States (those endowed by Congress to educate the young farmers of the country). From this registration the scientific Divisions of the Department select young men who will assist the Division scientists in their work, and have opportunities for post-graduate study and for better preparing themselves along the lines of applied science, whereby the producer is helped by the scholar. We pay these young men no more than we pay a laborer, and much of the work they will perform in the Divisions could be performed by skilled laborers.

Slight inquiry into education along the lines of agricultural science will show that there is no university in the land where the graduate of an agricultural college who has been studying along the lines indicated can take post-graduate work. The scientific Divisions of the Department of Agriculture come nearer furnishing the necessary facilities than can be found elsewhere. If two or three young men come to each of our scientific Divisions and study along the lines of the application of science to production in the field, the stable, and the farm factory, the Department will in a few years have a force from which it can not only fill vacancies when wealthy institutions take away trained men, but be able to supply the agricultural colleges, experiment stations, and other scientific institutions in the land with men of superior scientific attainments in these branches.

EFFORTS OF THE DEPARTMENT TO MEET THE DEMANDS FOR HELP.

By this new departure the Department is merely arranging to meet the imperative demands of the producers of the country for help to solve the problems that are beyond their education and their means. The Congress of the United States, in providing for the endowment of agricultural colleges and experiment stations, did more for the agriculture of the country than has been done by governmental agency for the people of any other nation. Congress could not endow these institutions with teachers trained in the applied sciences relating to the farm, but Congress has built up the Department of Agriculture and encouraged the development of the foremost scientists known in their several specialties. The step we have taken toward bringing the brightest students of the agricultural colleges to prosecute their studies under the supervision of scientists in this Department is one step necessary to complete the educational system.

Something no doubt remains to be done at the other end of the educational line. The education of the young farmer in the district and high schools should be such as to help him toward the agricultural college. The other educational institutions of the country have done their work well, but so abundantly that the college graduate upon leaving college is not sure of employment that will give the salary of a brakeman on the railroad. Only a very few of those who upon leaving college must earn their livelihood through their literary education are sure of incomes equal to that of a locomotive engineer. The great unexplored field for the educator is along agricultural lines. Half the people of the United States are interested in it. The prosperity of our country as a nation among nations depends upon it.

I hope to have the approval of Congress in this effort to provide for the higher education of the graduates of the agricultural colleges by appropriations sufficiently considerate to justify the very moderate expense that will be entailed.

AGRICULTURAL TEACHING IN THE COMMON SCHOOLS.

In my last Annual Report, I referred to the growing interest in elementary instruction in the sciences that relate to agriculture, and mentioned the special appropriation of $25,000 made by the State of New York to be used in aiding the introduction of nature teaching into the common schools and the carrying on of simple agricultural experiments in different parts of the State under the supervision of the college of agriculture of Cornell University. Encouraging progress has been made during the year in this movement. The work at Cornell has been materially extended, and colleges in other States are affording opportunities for teachers in the common schools to receive such special instruction as will fit them to give elementary courses in nature study. In Missouri a recently enacted law calls for instruction in agriculture and horticulture in the common schools, and during the past summer a considerable number of Missouri school superintendents and teachers spent some time in attending lectures and formulating elementary courses of instruction in these studies.

CONCLUSION.

The Department, through its Bureaus, Divisions, and Offices, is getting into more immediate contact with all classes of producers throughout the country. More extensive cooperation is being entered into between the Department and the experiment stations of the several States. Especial attention is being given to the reclamation of soils that have been reduced in fertility by injudicious management. Production from the soil in all parts of the United States is being diversified by importations from foreign countries. The scientist and the cultivator are working together for greater national prosperity through more economic production. The farmers of the country are having their knowledge increased through the publications of the Department and the experiment stations, and the future tillers of the soil are being better educated in the agricultural colleges as teachers are developed who more thoroughly understand the application of science to practical agriculture. The field of operations for the future activity of the farmer is from the Arctic Circle to the Equator. New problems, requiring scientific investigation and entirely beyond the ability of localities or private individuals to solve, are presented from both extremes. The especial attention of the Department in the future will be given to the production, under United States jurisdiction, of products of the soil that now come from foreign countries, keeping steadily in view the object for which the Department was organized—the help of the producer who is struggling with nature.

Respectfully submitted.

JAMES WILSON,
Secretary.

WASHINGTON, D. C., *November 21, 1899.*

WORK OF THE METEOROLOGIST FOR THE BENEFIT OF AGRICULTURE, COMMERCE, AND NAVIGATION.

By F. H. BIGELOW,
Professor of Meteorology, Weather Bureau.

INTRODUCTION.

A consideration of the development of meteorological science in the United States, especially in its practical application to agriculture, commerce, and navigation, involves mainly a review of the United States Weather Bureau and its work. Not only, as will be shown, is the study of meteorology largely confined in this country to its professors and other employees, but the application of the results obtained to the service of the farmer, the shipper, and the navigator, is and has been for years exclusively the province of the Bureau. Necessarily, therefore, a large part of the present paper must be devoted to a history of the Weather Bureau and an account of its workings.

THE ORGANIC LAWS ESTABLISHING THE WEATHER SERVICE.

The Weather Bureau of the United States has reached its present development under three organic laws. The joint resolution approved February 9, 1870, is as follows:

Be it resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of War be, and he hereby is, authorized and required to provide for taking meteorological observations at the military stations in the interior of the continent and at other points in the States and Territories of the United States, and for giving notice on the northern lakes and on the seacoast, by magnetic telegraph and marine signals, of the approach and force of storms.

In compliance with the appropriation bill of 1871, reports relative to the stages of water in the rivers were added to the above. The appropriation bill approved June 10, 1872, provided:

For expenses of storm signals announcing the probable approach and force of storms throughout the United States, for the benefit of commerce and agriculture, and that the Secretary of War be, and hereby is, authorized and required to provide, in the system of observations and reports in charge of the Chief Signal Officer for such stations, reports and signals as may be found necessary for the benefit of agriculture and commercial interests.

In the act transferring the meteorological work of the Signal Office to the Weather Bureau of the Department of Agriculture, approved October 1, 1890, the duties of the service are thus summarized:

The chief of the Weather Bureau shall have charge of forecasting the 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 interests: the display of frost and cold-wave signals; the distribution of meteorological information in the interest 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.

THE THREE EPOCHS OF METEOROLOGICAL SERVICE.

The acts of Congress indicate that the meteorological service of the United States has passed through three distinct epochs, each of which has been natural in the practical development of this branch of science. The laws are in fact but the crystallized expression of the outcome of years of experience on the part of those interested in meteorology. Thus, the laws of 1871 and 1872 mark the end of a long agitation, the purpose of which was to persuade Congress that forecasts of the weather were practicable in the United States and that an organized systematic effort to give the public due warning of the approach of storms was worth a trial. The organization of this service was intrusted to the Signal Service of the War Department. At first the service was for the benefit of navigation on the seacoast and on the Great Lakes, but it was soon extended so as to include the interior districts and the great rivers of the central valleys.

The experience incident upon the gradual extension of the service soon showed that it would be necessary to include the regions adjacent to the United States in order to secure the most efficient forecasts of the weather, especially the Dominion of Canada, along our northern border, for the cyclones; the West Indies, to the south and southeast, for the hurricanes, and also Mexico and even Alaska for other local effects. The benefits of the weather service were readily appreciated by nearly every industry and every department of our complex civilization. Climate and crop conditions were demanded for the farmer, and observations and warnings for the public and for railroad and water carriers. Hence, it soon became necessary to enlarge the scope of the service so as to include agriculture and commerce as well as navigation, and to extend the sphere of the meteorologist to cover the study not only of the dynamics and motions of the atmosphere, but of climatology (the prevailing temperature and rainfall), together with their effects upon human life. This great enlargement of the original idea regarding the scope of the work gradually produced an environment which became less suited to the duties inherent in the purely military service that had so successfully fostered this very growth through twenty years, till at length it was concluded that a more strictly scientific bureau could better carry on the work. Accordingly, the second epoch came to an end on July 1, 1891, when the Signal Service of the War Department was relieved of its meteorological duties and the Weather Bureau of the Department of Agriculture was organized and charged with the future of meteorology in the United States.

In the latter administrative department of the Government the civilian and scientific methods predominate, though it must be said that the spirit of subordination inherited from the Army discipline still continues, and tends to make the organization of the Weather Bureau more efficient and homogeneous than it otherwise could be. A detailed review of the incidents connected with these changes in the service, both on the practical and on the theoretical sides, involves such a multitude of facts as to be quite incompatible with any brevity, if treated fully; hence, only a summary description of the service can be attempted here.

PRELIMINARY HISTORICAL SKETCH OF METEOROLOGY.

AMERICAN CONTRIBUTORS TO METEOROLOGY PRIOR TO 1870.

During the eighteenth century but little progress was made in detecting any sort of regular lawful sequence in the apparently erratic phenomena known as the weather. Franklin had perceived that storms moved northeastward from Philadelphia toward New England, which view was the result of his observations and private correspondence regarding the exact time when the maximum severity of storms was felt at different places. Thomas Jefferson, at Monticello, and James Madison, at Williamsburg, in Virginia, had taken some simultaneous observations in the years 1772–1777, and certain conclusions were drawn from them. The belief gradually took shape among students of the day, both in America and in Europe, that storms had a progressive movement and a whirling motion about the center. Lavoisier and Borda, in France, proposed to establish stations over a large territory and examine the simultaneous records in order to detect the laws of storms. Mitchell, in America, Capper, in India, Langford for the West Indies, and Brandes and Dove, in Europe, had contributed certain notions on the subject, some holding that storms are whirls in the atmosphere, though generally the view was expressed that they are straight-line gales. Charts of various kinds were constructed by different individuals, and the publication of these at length placed students in a position to begin the slow advance from mere hypothetical conjectures regarding the motions of the air to the definite scientific knowledge of the laws which we possess to-day. It is quite remarkable to note the extent to which American students have been pioneers in these meteorological researches, their views having been confirmed or elaborated rather than originally suggested by Europeans in their studies.

During the nineteenth century the observations of atmospheric phenomena have been enormously multiplied all over the world, and a correct scientific classification of them around fundamental laws has proceeded steadily, if not very rapidly. In 1831 Redfield published his first essay, which contained these important generalizations: Storms and hurricanes are great revolving whirlwinds which turn from right to left and have a northeastward, progressive movement; the winds increase in violence toward the center, where a calm usually exists; storms are gyrating portions of the atmosphere in which they are carried along, and the low barometric pressure at the center is due to the centrifugal force. In 1843 the same author ascribed the great velocity of the wind at the center of tornadoes to the law that the product of the velocity at any point multiplied by its distance from the center is constant. In 1846 he described the warm southerly winds on the easterly side of storms and the cold northerly winds on the westerly side, and thus nearly apprehended the cause of cold waves. He seems to have been fully aware that the winds do not move exactly in circles about the center, but rather approach it in spirals, and he stated that his instructions to the engraver were to make the wind lines spiral or involute in shape on his charts, but that, for ease in drawing, circles were substituted, which gave an erroneous impression regarding the theory to his readers. He stated distinctly, in 1846, that these lines made an angle of about 48° with the tangent to the circle. Espy, who was at one time appointed meteorologist to the National Government, was the first to study and point out clearly some of the temperature processes which are going on in the atmosphere. He applied the laws of thermo-dynamics in 1841, at about the time when this subject first took shape in theoretical physics, and showed that an ascending mass of air expands its volume and cools its vapor contents down to saturation, thus causing rainfall; that a descending mass warms by compression, clears the air of clouds, and causes it to appear to be dry; he proved that in the condensation of aqueous vapor to water the production of latent heat retards the rate of cooling with the ascent, and showed that the daily heating of the lower strata by the sun's rays produces a general ascending buoyancy during the early portions of the day, thus developing the cumulus and cumulo-nimbus clouds,[1] which dissipate in the evening as the strata settle back toward the ground; he attributed the rainy belt in the Tropics to an ascending movement and the clear space at the eye of a hurricane to a descending current of air; he also attempted to show that the cause of storms consisted in the local buoyant ascent of heated air, which produced a radial indraft below in the lower strata; but he failed to see that this reasoning could not account for the prevailing low pressures which permanently surround the cold polar regions.

The Espy theory of the cause of storms, namely, the convectional

[1] By "cumulus" and "cumulo-nimbus" is meant the massive white clouds which form chiefly in the afternoons, often producing thunderstorms.

indraft in a radial direction, and the Redfield view that storms are essentially whirls in circles about a center with low pressure at that place due to centrifugal motion, contain elements in apparent contradiction to each other, and a long controversy ensued over the merits of these rival views, which is hardly yet completely settled in the minds of many students of meteorology. In 1843 Tracy published an article which added a new force in the construction of storms, namely, the right-hand deflecting component of motion in the Northern Hemisphere, which depends upon the rotation of the earth and is proportional to the velocity of motion and the sine of the latitude. Unfortunately, this was not noticed at the time, and it had no influence upon the controversy, though it is really decisive against Espy's theory of the radial direction of motion.

The labors of these intelligent students were rapidly bringing order out of chaos in meteorology. Such physical work was supplemented by the statistical results which were being compiled in various places. Coffin, in 1853, published his "Winds of the Northern Hemisphere." After his death, appeared his "Winds of the globe," edited by his son and the Russian meteorologist Woeikoff. He described the right-hand rotation of cyclones in the Northern Hemisphere and the left-hand rotation in the Southern. He considered storms to be eddies in the general currents of the atmosphere, and claimed that both Redfield and Espy had elements of truth in their theories, which must be mutually combined to produce a correct view of the subject. Loomis, of Yale College, also was engaged in the compilation of statistics and the construction of maps through his long active career as a meteorologist, and he added many important facts to our scientific knowledge, though no essential part in the theoretical development seems to be associated with his name. It was during the years 1850 to 1860, however, that the greatest advance was made in a systematic analysis of meteorological phenomena and that the reduction of the entire subject to definite mathematical expressions first took place. Prof. William Ferrel, of the Signal Service, has the honor of thus having first contributed an analytical description of the motions of the air, and therefore of having done most to establish meteorology upon a scientific basis. His work is so well known to students that it is not necessary to describe or comment upon it in this place. He was by nature a profound mathematician and an accomplished astronomical computer, and while some of his discussions are cumbersome, it must be remembered that he had not the advantage in his active years of advanced modern mathematics, which will surely find one of its most important applications in the study of the motions of the atmosphere.

Ferrel did especially good work in his treatment of the general motions of the air, but he is not now regarded as having been so successful in his handling of the local cyclones and hurricanes. His discussion of tornadoes was also ably presented, and can be improved at this time only in certain details. Regarding the cause and structure of local cyclones, Ferrel himself was never quite satisfied with his own conception. He saw distinctly the value of Espy's convectional buoyancy, of Redfield's gyratory rotation, and of Coffin's subordination of the local eddies to the general circulation of the air, and it is not too much to say that, while he wavered in his theory, he inclined strongly to Coffin's point of view. He unfortunately forced the parallelism of the local to the general cyclone so far that a reaction has taken place against him in recent years by students who have had the advantage of the use of the best modern materials. This mistaken comparison of the local cyclone with the general cyclone has been an important factor in the rather slow progress characterizing the last twenty years. In the hands of Ferrel, supplemented by the important contributions of many distinguished Europeans, meteorology has already reached such a development as to require a high order of mathematical talent to make any important advances.

THE WEATHER MAP.

The above brief account of the development of the principles of theoretical meteorology in the United States previous to 1870, the date when the subject was taken up by the National Government, has been necessary in order to show that meteorology had already acquired a firm standing among students of the subject. Yet, it is quite improbable that the Government would have been authorized by Congress to undertake such functions as were at that time assigned to it unless there had been in connection with the improvement in the theory a corresponding advance on the practical side, which would be of direct usefulness to the public. This consisted in the possibility of making forecast warnings of the approach of storms, in order to justify the heavy expenses connected with the collection of the observations, and the dissemination by telegraph of the information contained in the study of the simultaneous records. About 1784 Lavoisier, the famous chemist, suggested that instruments be scattered over France, and declared that with their aid "it would not be impossible to publish each morning a journal of predictions which would be of great use to society," so that the dream of forecasting the weather is a century old. After the invention of the electric telegraph, Lavoisier's idea became practicable, and in 1842 Kreil renewed the plan of collecting daily simultaneous observations of the state of the atmosphere. During the next ten years this view was urged by various scientific men, Redfield (1846), Henry (1847), Ball (1848), Maury (1851), in many papers and addresses. Brandes, Piddington, Espy, Redfield, Henry, Loomis, and others had been compiling weather maps from reports, and were convinced that there was sufficient sequence in the weather conditions to forecast them if the reports could be collected promptly enough and from a suitable number of widely distributed stations. The agitation therefore took the form of urging some cooperative scheme which would make this possible.

In 1848 Glaisher, and in 1851 the Crystal Palace authorities, made some weather maps. In 1856 weather charts were displayed every day by the Smithsonian Institution, in Washington, D. C., under the direction of Professor Henry, wherein appropriate symbols indicated the state of the atmosphere over the United States, and this enlightened plan was continued till interrupted by the civil war in 1861. Leverrier, the great astronomer of France, in 1854 studied the European reports received concerning the weather. In 1855 he submitted a plan to the Emperor for a meteorological network over France. In 1856 he began to make maps, with a system of thirteen telegraph and eleven post stations. In 1857 he published an international bulletin. In 1858 it became a daily bulletin. In 1863 he first made predictions for ports. On September 11, 1863, he printed the weather map for the day, and it has not been discontinued since that time. It is thus seen that to France is due the credit of first issuing a permanent set of daily maps with forecasts. After the conclusion of the American civil war efforts were renewed to set on foot a plan of meteorological operations for the United States. While the great extent of its territory made this country a most favorable theater for such a project, there was necessarily connected with the undertaking a very considerable expense for telegraphic messages, so that a scheme of operations on a large scale was essential to its inauguration.

In 1868 Prof. Cleveland Abbe, the veteran meteorologist of the service in this country, while director of the Cincinnati observatory, secured the assistance of the Cincinnati Chamber of Commerce and the Western Union Telegraph Company, so that he was able to prepare and issue a daily bulletin, and afterward a map based upon thirty stations covering the region from the Atlantic coast to the Rocky Mountain slope. These maps gave the temperatures, cloudiness, rain, snow, and the direction of the wind, but no pressure or isothermal lines. During the years 1845 to 1865 Congress was being urged to give authority for storm and weather predictions, by Espy and Henry on behalf of the Smithsonian Institution, Maury on behalf of the Navy, General Reynolds on behalf of the Army Engineer Corps, Major Lachlan on behalf of the American Association for the Advancement of Science, and Commissioner Watts on behalf of the Department of Agriculture. In 1869 Gen. A. J. Myer presented to the Secretary of War a scheme of weather warnings suitable for execution by the Signal Corps. Prof. I. A. Lapham, of Milwaukee, Wis., sought to secure for the Great Lakes the benefit of weather forecasts by extending the service over that region, and solicited the cooperation of the Chicago Board of Trade. He drew up a petition to the Chicago Academy of Sciences, but one of its most clear-minded members, Hon. Halbert E. Paine, said, "This petition should go to Congress, and the weather predictions should be for the whole country and not for any small section thereof." The indorsement of the National Board of Trade was secured. Mr. Paine obtained the approval and support of the Secretary of War, and, happily, procured the passage of the joint resolution by Congress, already quoted, which was approved February 9, 1870. Thus, the service of forecasting weather conditions was formally authorized by the Government of the United States and intrusted to the Signal Corps of the War Department, of which Brig. Gen. Albert J. Myer was in command.

ADMINISTRATION OF THE WEATHER SERVICE.

The successive chiefs of the Weather Service, including the chiefs of the Weather Bureau since its transfer to the Department of Agriculture, with their respective terms of office, have been as follows:

Brig. Gen. A. J. Myer, February 9, 1870, to August 24, 1880.

Adjt. Gen. R. C. Drum (acting chief), August, 1880, to December, 1880.

Brig. Gen. W. B. Hazen, December, 1880, to December, 1886.

Brig. Gen. A. W. Greely, December, 1886, to July 1, 1891.

Prof. Mark W. Harrington, July 1, 1891, to July 1, 1895.

Prof. Willis L. Moore, July, 1895, to the present time.

FEATURES OF THE SEVERAL ADMINISTRATIONS.

The prominent features of the several administrations, briefly stated, are as follows:

General MYER organized the service with the material at his hand, namely, the observers and sergeants of the Army Signal Corps. He introduced nearly all the methods of operation still in use by the office, including synchronous observations, telegraph circuits, weather maps, bulletins, synopses and forecasts, signals and distribution of warnings as widely as possible, the publication of daily, weekly, monthly, and annual reports of regular work, special investigations, instructions to observers, and information to the public. He sought to have organized a separate, permanent corps of officials, specially devoted to this service, instead of depending upon the military assignments of a more or less temporary character, but he was unable to accomplish this important improvement in the organization. General Myer also succeeded in securing the cooperation of the European weather bureaus in entering upon a plan of international simultaneous observations, which were to cover the Northern Hemisphere as far as possible. These were begun in 1875 and continued through General Hazen's term of office, till in 1887 General Greely was obliged to discontinue them on account of the expense.

General DRUM'S administration was so far of a temporary nature as to give no opportunity to impress new methods and results upon the service.

General HAZEN sought in every way to improve the service, which had been founded on really broad lines, and became convinced that the military corps ought to be supplemented by a corps of civilian assistants, who should be favorably known for scholarship in meteorology, and who were to be free to pursue such studies, in an uninterrupted manner, as the service demanded. A body of such civilians was appointed in 1881–1884 by General Hazen, and they have become an indispensable part of the organization of the service. General Hazen furthermore entered upon the international scheme for the exploration of the Arctic Zone by simultaneous meteorological and magnetic observations, which was executed in 1881–82.

General GREELY took up what was now a well-organized and fully-equipped service already fixed in the esteem of the public in this country, and carried it along the same lines. He made further efforts to secure from Congress an independent set of officials for the meteorological service of the Signal Corps, and finally succeeded in that purpose by procuring the act of Congress approved October 1, 1890, which not only made permanent the organization, but also provided for the absolute transfer of the meteorological work from the Signal Corps of the War Department to the Department of Agriculture. The same act provided for the assignment of Army officers to duty in the Weather Bureau, and this remained in force till the outbreak of the Spanish-American war, when the provision was revoked in May, 1898, so that now the service is not only organized as a permanent corps, but is composed wholly of civilians. During General Greely's administration the fruits of several years' observations of the weather conditions of the United States began to appear in a series of valuable compilations, giving the normal distributions of pressure, temperature, rainfall, and the climatological features of the country.

The transfer of the meteorological work from the War Department did not change its essential features in any important respect, but left it free to develop along the lines most suited to its purpose.

Professor HARRINGTON, in his administration, was occupied by a transfer of the officials who resigned from the Signal Corps, and who were generally reappointed in the Weather Bureau; by a reorganization of the divisions in the office; by a considerable extension of the activities of the service in the number of stations which were occupied, the number of volunteer observers engaged, and the publication of a greater number of maps, reports, and special investigations. A somewhat unfortunate though very natural change had already manifested itself before this time, and yet one which could not be readily counteracted, namely, the practical absorption of meteorological studies in the United States by the national service and the diminution of the number of independent students scattered over the country. The growth of meteorological records, which are necessarily deposited at the central office, gives the professors of the Weather Bureau so great an advantage over outsiders in accessibility of the materials for scientific research as to practically exclude them from serious competition along these lines. This is to be regretted, because an intelligent body of students associated with the universities of the United States would not only serve to spread the knowledge of the higher meteorology, but would form a body whose opinions as to the good of the service should be always important.

Professor MOORE has met the practical wants of the public by an increase in the facilities for distribution of forecasts, by improvements in the local daily weather-map, in the unification of the form of the local publications in the different States, by several important scientific investigations, including the relations of the sun to the earth through magnetism, the exploration of the lower strata of the atmosphere by means of kite ascensions and the higher strata by cloud observations in cooperation with the international commission during 1896–97. Many reports of permanent value continue to be issued by the office, and these are usually of a very practical character, though sometimes necessarily technical.

METEOROLOGICAL REPORTS AND STORM WARNINGS.

On November 1, 1870, at 7.35 a. m., the first systematized synchronous meteorological reports ever taken in the United States were read from the instruments by the observer sergeants of the Signal Service at twenty-four stations and placed upon the telegraph wires for transmission.

On the same day the tabular bulletin reports were furnished to twenty-four cities. A copy of this bulletin is given here as an interesting record. The drawing of isobar lines is quite impracticable from the data, but an improvement was speedily effected in the determination of the heights of the stations and the reduction of the actual pressures to the sea level, as shown by the fact that early succeeding bulletins gave smooth isobars. An excessive amount of space seems to have been assigned to the record of the wind velocity in three different scales. Provision was also made in the form of the table for the twenty-four hour changes in pressure and temperature, and for the relative humidity.

Copy of the first daily bulletin published by the United States Signal Office from the observations taken November 1, 1870, 7.35 a. m.

Place of observation.	Height of barometer.	Temperature.	Direction of wind.	Velocity of wind per hour.	Pressure of wind per sq. foot.	Force of wind.	Amount of cloud.	State of weather.
	Inches.	*Degrees.*		*Miles.*	*Pounds.*		*Per cent.*	
Boston	29.65	44	W.	3	.04	Gentle		Fair.
Buffalo	29.38	40	W.	7	.24	Light		Clear.
Cheyenne	27.12	45	W.	13	.83	Brisk		Clear.
Chicago	30.03	40	SW.	14	.75	Brisk		Clear.
Cincinnati	29.52	40	SE.	5	.12	Light	1.4	Clear.

Copy of the first daily bulletin published by the United States Signal Office from the observations taken November 1, 1870, 7.35 a. m.—Continued.

Place of observation.	Height of barometer.	Temperature.	Direction of wind.	Velocity of wind per hour.	Pressure of wind per sq. foot.	Force of wind.	Amount of cloud.	State of weather.
	Inches.	*Degrees.*		*Miles.*	*Pounds.*		*Per cent.*	
Cleveland	30.09	35	SE.	12	.83	Brisk		Clear.
Detroit	29.84	37	S.	5	.12	Light		Clear.
Duluth	28.99	37	SW.	4	.07	Light		
Key West	29.98	75	E.	4	.07	Gentle	4.4	Cloudy.
Lake City, Fla	30.05	62	0	0	0	Calm	1.4	Clear.
Milwaukee	30.07	42	W.	12	.83	Brisk		Clear.
Nashville	30.08	51	N.	2	.02	Gentle	1.2	Fair.
New Orleans	30.08	64	NE.	3	.04	Gentle	1.4	Fair.
New York	30.12	45	0	0	0	Calm		Clear.
Omaha	29.32	36	S.	4	.07	Gentle		Clear.
Oswego	29.94	44	W.	20	1.96	Very brisk		Fair.
Pittsburg	29.32	38	S.	3	.04	Gentle	1.4	Fair.
Rochester	30.03	40	W.	7	.24	Light	3.4	Fair.
St. Louis	29.91	45	SE.	7	.24	Light		Clear.
St. Paul	29.50	38	E.	1	.01	Very light		Clear.
Toledo	30.00	38	S.	2	.02	Gentle		Clear.
Washington	30.03	45	W.	1	.01	Light	1.4	Fair.

The first storm warning was telegraphed and bulletined along the Lakes on November 8, 1870. The issue of "Synopsis and probabilities," as they were styled, was commenced on February 19, 1871, and were made thrice daily after that date, the forecast being intended to cover only the twenty-four hours then next ensuing. Signal stations for cautionary warnings of storms were soon established along the Atlantic and Gulf coasts, and the first of such signals was displayed on Tuesday, October 26, 1871, at 7 p. m., at the port of Oswego, N. Y. Till the middle of 1872, the work of forecasting devolved upon the civilian assistant, and after that time was shared between him and officers detailed from the Army.

The growth of scientific work under General Hazen called for the services of specially trained scientists, and a number of civilian professors were appointed, but they all, with two exceptions, resigned in a few years; the transfer of the service to the Department of Agriculture and the opening of the Chicago and the Pacific centers for forecasts called for new men.

INSTRUCTION IN METEOROLOGY.

The first task devolving upon General Myer, in the organization of the service, was that of instructing a sufficient number of officers and sergeants as forecasters and observers, the definition of the duties in general meteorology, and in the proper transaction of the business connected with this new branch of the service. At Fort Whipple, now Fort Myer, Arlington, Va., there existed a school of instruction for officers of the Army and Navy, and the work of teaching a corps of meteorologists was added to its formal functions. During the first year seventy-three sergeants were instructed in the "Manual of signals," the "Practice of electrical telegraphy," Loomis's "Meteorology," "The Smithsonian instructions," and "Instructions to observer sergeants." Among the earliest papers published by the office were a practical treatise on meteorological phenomena, adapted to the use of observers, and instructions as to the details of office duties. Such writings have been kept prominently before the office ever since, and they have gradually covered every conceivable phase of the subject likely to be of value to the officials themselves or to the public. In 1872 there was established the so-called study room, under the charge of Professor Abbe, where scientific and practical questions were taken up for discussion, and this did good work in educating several men, who have since become well known in science, till it was officially abolished in 1886. Since that time the scientific problems have been assigned by the chief of the Bureau to the several professors, or else to boards especially appointed to report on definite propositions.

In the year 1882, by direction of General Hazen, the school of instruction at Fort Myer assumed a decidedly collegiate aspect in the extent and strength of the instruction offered. Courses of lectures were delivered by Professor Abbe on instruments, published later in 1887; by Professor Upton on practical astronomy; by Professor Hazen on meteorology; by Professor Waldo on elementary mathematics and thermo-dynamics. Other lectures on more general topics were delivered by Lieutenants Story, Dunwoody, and Birkheimer. This very commendable attempt to provide a much higher grade of education for meteorologists lasted until 1886, when the school at Fort Myer was discontinued. The demand for higher scientific instruction has been met to a very limited extent by the colleges and universities of the United States, and yet, as a distinct subject, meteorology has been taught in only a meager fashion up to the present time. This state of affairs is accounted for to a considerable extent by the fact that entrance upon a career as a meteorologist is almost entirely limited to the Government service, together with the circumstance that most of the routine work of the office, making the observations and distributing the forecasts, is of an elementary kind, and does not demand the knowledge of any large amount of mathematics or physics. The few professorships open to young men are so slowly attained as to discourage ambition in this direction. In 1892 and the following years the entire service was classified and became subject to the civil-service rules, so that examinations are now the rule for admittance to all grades. Under Professor Moore's administration progress is being made in prescribing requirements for entering the Government weather service and for promotions within it up to the highest grade, so that the educational side of the Weather Bureau is likely to assume gradually a definite and permanent character.

MEANS OF INSTRUCTION AND INFORMATION FOR THE PUBLIC.

Besides the persistent efforts which in one form or another have always been made to instruct the officials of the service in their duties as observers and in their scientific understanding of the problems of meteorology, a much more extensive and difficult task has been carried on simultaneously in the endeavor to teach the public to appreciate and appropriate the results of this systematic research into the laws controlling the weather. In spite of discouraging results attending the attempt to propagate much exact knowledge of this complicated science to a large population, the evidence preponderates that the work of the Government has already been of an enormous value to the whole country from an educational point of view. The inevitable failures attending the attempt to forecast weather conditions for periods of from twenty-four to forty-eight hours in so unstable a medium as the ever-changing atmosphere, filled as it is with long currents of different temperatures, large and small vortices, the sensitive physical processes giving rise to clouds and precipitation, must be admitted as an unavoidable part of the imperfections of this practical work. These errors were formerly used by the press and by critics generally as a ground for complaint against the service, but now it is notable how greatly improved has become the tone of criticism, which recognizes that the successes far outweigh the failures in forecasting. While there has not been any important advance in the amount of instruction given by the universities in the higher theoretical meteorology of late years, yet it should be observed that meteorology is extending rapidly throughout the common schools of the country as a required branch of instruction for every child, and it can be inferred that this process of beginning at the bottom will culminate in producing occasionally an individual who shall attain strength and success in studies embracing the highest reaches of science pertaining to the physics of the atmosphere. These changes have certainly resulted from the persistent propaganda of publications emanating from the Weather Bureau during the past thirty years.

THE ANNUAL REPORTS.

Among the most important publications of the service must be placed the Annual Reports of the chief of the Weather Bureau, which now comprise a most creditable array of volumes, filled with interesting and valuable information regarding the administration of the work and the latest results of scientific investigations. Therein one may find an account of the gradual growth of the service; a description of all the severe storms experienced since 1870, whether cyclones, hurricanes, or tornadoes, together with marvelous incidents in the history of the latter destructive agents; statistics of the wreckage of vessels on the Lakes and on the seaboard, showing a remarkable lowering of the percentages of wrecks in consequence of the obedience of navigators to the storm warnings; descriptions of the growing dependence of the railroads and other public carriers upon the information regarding heavy snowstorms, cold waves, and floods, which endanger all perishable products during transportation; data of the gradual improvement on the part of small farmers and great agriculturists in the care of their stuffs in consequence of the frost warnings and the increased knowledge of the effect of seasons and climate upon the crops; also facts showing the almost complete reliance of the cotton, rice, corn, wheat, and raisin industries upon the information regarding normal or abnormal temperatures and rainfall. There will also be found in these reports a description of the instrumental equipment of the meteorological stations, with the gradual evolution of self-registering apparatus of all kinds by means of electrical attachments, including barometers, thermometers; humidity, sunshine and cloud recorders; anemometers and vanes for the force and direction of the wind; self-measuring rain gauges, and kite and cloud-height apparatus of various kinds. Many of the self-registering pieces of apparatus display the greatest mechanical ingenuity in the devices employed, and their resulting records agree so closely with direct observations on the standard instruments as to be perfectly acceptable within the limits of accuracy required in current observations. (For kite and cloud-motion apparatus, see Pls. I and II.)

The practicability of such a service of course depends upon the telegraph for its efficiency in promptly collecting the observations taken simultaneously on the Atlantic and Pacific coasts, on the Lakes and the Gulf of Mexico, and through the Rocky Mountain region and the central valleys. The magnificent result of receiving at Washington, D. C., and at all the larger cities of the country at the same time the complete records from one hundred and fifty stations within an hour after the observations are made is testimony to the skill and experience of the electricians of the Weather Bureau and the telegraph companies. This result depends upon special arrangements which have been slowly brought to perfection. The first of these arrangements is the cooperation of the telegraph lines, by which special wires are devoted to the Government service during certain hours of the day, when the weather messages take precedence of all private dispatches; in 1870 there were six telegraph companies concerned in transmitting weather messages, but these have all been merged into one; in 1871 there was some controversy as to the financial terms of the telegraph service, but it was settled by the fixing of rates through the Postmaster-General, and later Congress vested in the Secretary of Agriculture the power to make contracts with the telegraph companies; also to prescribe the precedence of all Government messages. The second arrangement consists in the establishment of certain telegraph circuits, including groups of cities in an extensive territory, so regulated that the same message is recorded simultaneously at all the

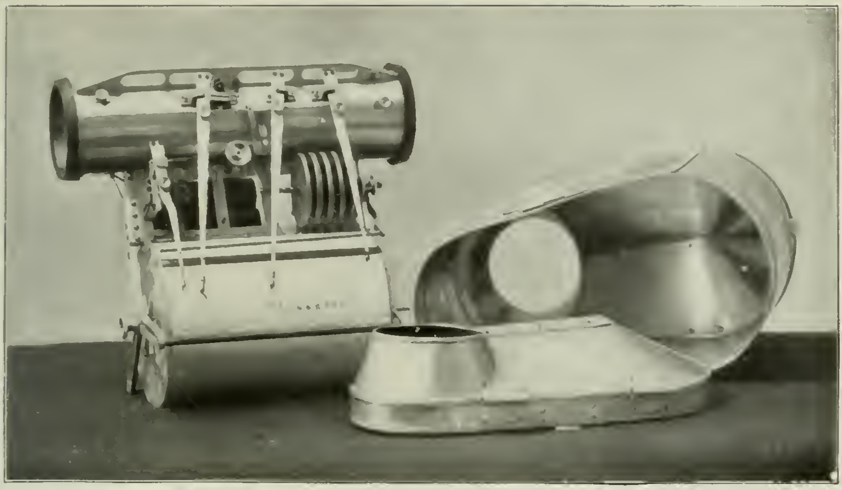

FIG. 1.—THE MARVIN METEOROGRAPH.

[Self-registering instrument to record the pressure, temperature, humidity, and wind velocity of the air. Very light in construction; adapted to kite ascensions where the minimum of weight is required for lofty flights. Used in the explorations of the lower atmosphere in 1898.]

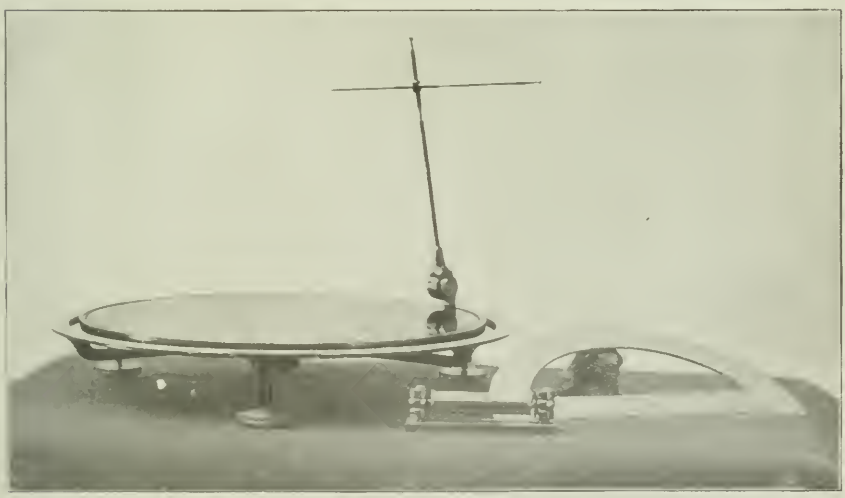

FIG. 2.—THE MARVIN NEPHOSCOPE.

[Mirror with attachments, by means of which direction and relative velocity of cloud motions can be determined. Used at the Weather Bureau stations during the International Cloud Survey of 1896–97.]

FIG. 1.—PREPARING TO FLY WEATHER BUREAU KITE.

FIG. 2.—WEATHER BUREAU KITE IN THE AIR.

[The kites shown are cellular or Hargrave, which have been perfected by the Weather Bureau. They fly with great steadiness, and are held by a fine steel wire and iron reel at the ground. A single kite has ascended to 8,000 feet, and several kites in series have risen to 13,000 or 14,000 feet.]

stations on the circuit; by an ingenious arrangement of the order of transmission of the circuit messages not only Washington, D. C., but many other cities have the exact weather records furnished for the hour of the observations; this has become quite necessary, because at many of the large cities weather maps are constructed and printed similar to the one in Washington, D. C., and which, though the latter is somewhat larger and more complete, practically contain the same important information; from many local centers the Washington forecast and the map itself are distributed to an enormous population and displayed in all the most important places of business and in the schools and private institutions. The third arrangement required was a method of reducing the expense of telegraphic messages to a minimum, since the actual cost of transmitting so many million words per year is an exceedingly heavy item; this has been done by constructing a compact and ingenious cipher code which can be readily translated, and in which five or six words give all the data which would otherwise require twenty-five or thirty words; the bill for telegrams alone under this cipher code is about $180,000 annually, and it may be readily inferred how great is the saving to the public in this direction.

Furthermore, the Annual Reports contain a complete statistical statement of all the important meteorological records made at the telegraphing stations, compiled so as to give the normal values of the pressure, temperature, precipitation, and wind movements. These statements have been continued from year to year in the same form, and it is now proposed to combine them into a complete scheme of normals based upon the work of the past quarter of a century. If such normals can be formed at intervals of twenty-five years, many questions regarding the long-range variations of the climate and weather will be finally answered for the benefit of future generations. When we reflect that astronomers have been engaged for several centuries in constructing the mean values upon which the larger questions of the structure of the universe depend, it may not be amiss for meteorologists to patiently continue a campaign as far-reaching as that of the astronomers in its outlook.

The discovery of the laws affecting the seasonal changes would certainly be of such benefit to mankind, in the complex civilization upon which modern life is entering, as to justify the expense and the patient labor involved in such a contribution from each generation to its successor. The crude method of tilling the soil common in these days will certainly give way to an exact economical procedure, based largely upon the result of meteorological research, increasing in precision with the lapse of time. There already exists in the archives of the Weather Bureau an immense quantity of valuable material calculated to serve these purposes. The great mass of weather observations, the collection of which is characteristic of this branch of science, is being systematically studied and condensed year by year in the records division, so that, before the original records are placed in the fireproof vaults, the central facts are extracted and appear annually in the report of the chief of the Bureau.

The expert investigator must be intrusted with the work of discussing the results in special researches, and the Annual Report contains a series of valuable papers drawn up on these lines. Thus, there have been published papers on the laws of storms; the physical processes in the air; the climatic conditions; the relation of crops to the weather; atmospheric electricity; terrestrial and solar magnetism; auroras; eclipses of the sun; Ferrel's treatises; Langley's researches on the solar constants; Abbe's translations; instruments and cloud studies; Bigelow's reports on magnetism, storm tracks, and the international cloud observations; a series of professional papers containing reduction tables in all branches of the subject; scientific notices; and a set of scientific bulletins on a variety of subjects. The Annual Reports also contain the results of the great work of the international simultaneous observations over the Northern Hemisphere, which were inaugurated by General Myer and published from January 1, 1875, to June 30, 1889. This vast series of observations has been compiled in a set of valuable charts and distributed in recent years, but it is believed that too little research work has been done to bring out the laws which are contained within these records. There is also an account of the international polar expeditions of 1882–83, when General Greely had charge of the American expedition to Fort Conger and Lieutenant Ray of that to Point Barrow.

THE MONTHLY WEATHER REVIEW.

Another important method of instructing the public in the science of meteorology has been the regular publication of the Monthly Weather Review, first issued for January, 1873, which was extended backward to July, 1872, and reprinted in the annual volume. For the next ten years these Reviews were reprinted in the Annual Report itself, but since 1884 they have appeared as a separate publication only. The Monthly Weather Review has regularly contained an accurate description of the incidents connected with the severe storms which have developed in the United States, giving the facts regarding warnings issued by the Bureau, the path of the storm and its intensity, and the damage inflicted, if important; the tracts of the high and low pressure areas across the country have been carefully charted from month to month; there are details of all the other important weather phenomena, and the weather record of several thousand volunteer observers, who are gradually constructing the complete climatological data for the normals and abnormals of temperature and precipitation; important reports on scientific research have usually been included in this publication, and they still form an occasional feature; in late years a series of interesting short notes of a more popular character has added to the value and popularity of the publication.

THE LIBRARY.

It may be stated in connection with this subject that the library of the Weather Bureau has grown steadily since 1870 at the rate of about 700 titles a year, till we now have something like 17,000 books and 3,000 pamphlets. The collection is strong in strictly meteorological data, and it is fairly complete in the department of physics and in the current periodical scientific literature. The library is provided with a card catalogue, an extensive bibliography of meteorology, and a foreign index of scientific titles.

THE CLIMATE AND CROP BULLETINS.

At the very beginning of the operations of the Signal Office a strong effort was made to obtain the active cooperation and support of the agricultural societies of the country and the boards of trade of the cities, who should, it was proposed, in conference with the chief, devise plans for practical weather work, and by missionary efforts in their respective communities should interest the people in meteorology, as well as instruct them in the utility of the national service. In the report of 1872 is contained a long list of such cooperating organizations. This system of mutual support was of the greatest value in establishing the weather service firmly among the necessary adjuncts of our modern life; but the important fact to note is that this beginning soon consolidated into one of the most important permanent features of the service. Such a development of local activity in the several States led to the establishment of the system of State weather services. There had been a few detached attempts by the different States, New York (1825), Pennsylvania (1837), Massachusetts (1849), Iowa (1875), and Missouri (1876), to apply local funds to the study of problems of interest to the special districts, having particular reference to the agricultural requirements and a knowledge of the effect of the climate upon crops. The experience of ten years with the national service showed that it could be efficiently supplemented by the addition of reports from each county in every State of the temperature, the rainfall, and the conditions and need of the crops. On the proposal of Lieut. H. H. C. Dunwoody and Professor Abbe such a cooperation was organized with the States, which one after the other took up the plan.

In 1881 the scheme was formally begun, and it has developed into the useful work now carried on by the climate and crop division of the Weather Bureau. The work consists in collecting by telegraph or postal card the required information and discussing the same prior to publication. This takes two forms, the compilation of special monthly reports by the several States and Territories, and the construction of weekly reports by the national Weather Bureau. The monthly reports by States at first were incomplete so far as the total number of States was concerned, and the style of the publications was very irregular when compared together and sometimes unsatisfactory. As the result of Professor Moore's efforts to secure uniformity these faults have at last been remedied, and nearly every section now publishes, in a uniform type and size, a monthly report of the climate of its region. In 1887 the Signal Service began to publish the national Climate and Crop Bulletin, giving each week an account of the conditions of all agricultural interests of the country. At first it contained about 600 words, with a summary of the general weather, and especially of the temperature and rainfall; then statements regarding the progress in farm work and the effects of weather on the crops were added, the reports being derived originally from the farmers themselves. In 1891 the Bulletin was enlarged and improved by adding two charts, showing the variation of the temperature and rainfall from the average normal conditions in the several districts for the week of issue; in 1891 brief telegraphic reports from the several States giving the condition and prospect of the crops were made a regular feature of the preparation; in 1894 two more charts, the temperature extremes and the total rainfall, were added; the Bulletin, therefore, now contains four charts, a general summary of the weather, and brief reports on the condition of the crops for each State. The climate and crop service as at present organized has forty-four sections, including Puerto Rico and Cuba, and utilizes 13,000 mail reports, furnished by more than 3,000 voluntary observers. Each section, besides providing material by telegraph for the national Weekly Bulletin, issues a local bulletin, in which the climatic conditions are fully and accurately described. It is obvious that such records must ultimately make the climate of the United States a subject of exact knowledge, and that in the future the most successful farming will take it into account.

THE DAILY WEATHER MAP AND FORECAST.

Besides the special, the annual, the monthly, and the weekly reports another most important publication remains to be mentioned. This is the Daily Weather Map. The primary object in establishing the weather service of the United States was the issuing of warnings of the approach of storms and floods for the benefit of commerce and transportation, though, as already shown, it logically was extended to cover the agricultural interests in the most complete form possible.

These warnings must be based upon simultaneous observations taken at stated hours, collected with the utmost rapidity, transferred to charts, studied and discussed by practical experts, who, by their knowledge of the weather laws, should give the best interpretation to the conditions in the form of forecasts. The daily weather report consists of four parts: (1) The bulletin of the weather conditions, pressure, temperature, rainfall, and wind direction and velocity; (2) a map displaying the isobars, isotherms, wind direction, state of the sky, areas of rain and snowfall during the past twelve hours, storm signals, cold-wave signals, and thunderstorms; (3) a synopsis of the general weather conditions of the United States; (4) a detailed forecast for the several regions of the country. These daily maps were issued originally November 1, 1870, as the "Weather bulletin," being at first made by a new manifold process, and they were published in the daily newspapers of many cities. About March, 1872, they began to be reprinted under the title "Daily bulletin of weather reports, with synopsis, probabilities, and facts." Subsequently a small-sized weather chart was added, being printed by lithography.

In the course of 1872 the scope of the map was enlarged, and it soon contained the original data of observations, the isobars, isotherms, synopsis, and probabilities. The reports of the river stages appear regularly on the same sheet; also an account of the storm signals, cold-wave signals, frost warnings, local storm warnings, and other phenomena of importance to the public. Almost at the outset the system of observations for the United States embraced the Canadian provinces; rather irregular reports were received from the West Indies during the hurricane season, until May, 1898, when a regular permanent service was established throughout that region. During the first years of the work three daily maps were prepared, made up from observations taken at 7.35 a. m., 4.35 p. m., and 11.35 p. m., Washington time, thus dividing the day into periods of about eight hours. This tridaily series of maps was changed in 1888 to a bidaily series, taken at 8 a. m. and 8 p. m., all times being those of the seventy-fifth meridian. In 1895 the printing of copies of the evening maps was suspended at Washington, D. C., and now the published maps at Washington City and the other large distributing centers are made from only the morning observations. The observations were made at less than 50 stations in 1871, but this number was increased in a few years to 150 stations, which sufficiently cover the territory under consideration to record all the general conditions of the atmosphere. The distribution of the resulting morning forecasts begins in less than two hours after the instruments are read, first by telegraph and telephone to about 1,000 centers of distribution, thence by telephone, mail, and railway-train service to more than 73,000 addresses, the greater part being delivered early in the day, and none later than 6 p. m. Besides these 1,000 telegraph distributing centers, the forecasts are telegraphed, at Government expense, to about 1,800 additional places, to be communicated to the public by means of visual and sound signals, the former consisting mainly of flags and the latter of steam whistles. At the telegraph distributing centers an immense number of the forecast messages are quickly printed by hand stamp and logotypes on postal cards bearing an official frank. These are mailed to all communities that can be reached not later than 6 p. m. of the day of issue, and suitably posted for the benefit of the public.

There is, besides, an additional system of distribution, by which more than 8,000 stations are furnished by telegraph at Government expense, as occasion justifies, with the "emergency warnings," that is, for hurricanes, cold waves, frosts, or local storms of unusual severity.

With this effective system, which is being extended and improved as opportunity affords, there is scarcely a community in the entire country that does not receive the benefit of the forecasts of the Weather Bureau. As soon as the forecasts are prepared they are sent to the press associations, through which they reach all important newspapers and are thereby given an almost unlimited circulation through the country. The morning forecast only is used for visual and sound signals; in the bulletin displays by the various means of distribution the morning forecast is also mainly used, the prediction applying more particularly to the following day. The evening forecast is published in the morning newspapers of the succeeding day and the morning forecast in the evening papers of the same day on which the forecast is made. A system of special reports from stations, in cases of unusual weather conditions in any district, supplement the regular observations, whereby the progress of a storm may be more closely followed. Special bulletins are also issued detailing the history of a hurricane or violent cyclone along the most important portions of its track. The verification of the forecasts shows that on the average about 82 per cent are strictly correct. A large portion of the failures are due to minor irregularities in the location of the rainfall or temperature changes, and these are really unimportant to the public. Contrary to general opinion, it is much less difficult to forecast the direction and force of well-defined and even dangerous storms than the common variations of the weather, when the conditions are flat and the course of the weather really uncertain; it is very seldom that any dangerous winds are not timely predicted by the Weather Bureau.

For some years the view prevailed that a local observer could forecast better for his immediate district than the national official at the central office, but after an extensive trial it was found that the Washington City forecasts verified 4 or 5 per cent better than the local forecasts, and the local system was therefore abandoned. It is difficult to obtain any very exact account of the actual saving of property to the public as the result of these storm warnings, but it is everywhere agreed that it amounts annually to a very large sum. The direct cost of the weather service to the people has for several years been less than $1,000,000 annually, and those in the best position to judge believe that the salvages alone would cover the expense of the work. This is quite independent of the many advantages accruing to our civilization from the agencies above described for serving the public in an agricultural, commercial, and educational way. The committees of Congress which are charged with inspecting the money value of the estimates are in many instances ready to recommend the appropriation of more money than even the chief of the Bureau or the Secretary of Agriculture asks for. Another fact is that there has been a steady natural growth in the operations and in satisfying the legitimate needs of the public, so that the people see for themselves the practical advantages of this great scientific work.

CONTRIBUTIONS OF THE WEATHER BUREAU TO METEOROLOGY.

The Weather Bureau has always sought to bring its methods to the knowledge of the public by courteously explaining the details of forecasting to all visitors at the central or local offices. It has made very creditable exhibitions at the world's fairs at Philadelphia, Chicago, New Orleans, Atlanta, Omaha, and Paris. It has put itself in line with all the great international reforms by advocating and adopting international standards of measures and standard time for its observations. It has organized the international simultaneous observations of 1875–1887, and cooperated in the international polar expeditions of 1881–1883, and in the international cloud observations of 1896–97. It has sent delegates to European meteorological congresses. It has contributed to meteorology several standard memoirs—Ferrel's "Professional papers," Nos. 8, 12, and 13, his "Recent advances," his reports on "Psychrometry," and on "Reduction to sea level;" Abbe's "Meteorological apparatus and methods," his "Storm and weather predictions," his two "Collections of translations;" Marvin's reports on instruments of various kinds and on kites; Bigelow's reports on magnetism, on storms and storm tracks, and on clouds; and reports by Mendenhall on atmospheric electricity, by Finley on tornadoes, by Henry on rainfall, by Hazen on thunderstorms, by McAdie on lightning; besides a multitude of minor papers of every kind. Special observations at the higher levels of the atmosphere have been made by means of the mountain stations—Mount Washington, Mount Mitchell, Pikes Peak; by cloud heights with theodolites; by kite ascensions, and by eleven balloon voyages. Several series of hourly observations are regularly taken of all the meteorological elements; the vertical gradients of the pressure, temperature, and vapor have been discussed by several methods; a great deal of attention has been given to plateau barometry, together with the determination of the elevation of the stations throughout the United States, and the instrumental and atmospheric corrections. The dynamic problem of the motions of the atmosphere is kept steadily in view, and advances are being made from time to time in this most important subject.

LATEST VIEWS ON THE THEORIES OF THE ORIGIN OF STORMS.

Perhaps it may be well to close this paper by stating the latest views on the theories of the origin of storms, which have been discussed by means of nearly every conceivable hypothesis during the past fifty years. The question involved has been how much emphasis should be given to the horizontal dynamical action of the large general currents of the atmosphere, due to the polar-tropic differences of temperature, and how much to the local vertical convectional action due to surface heating. Some meteorologists have laid stress upon one of these theories, and others upon the other, but, as in the Redfield-Espy controversy regarding the circular and the radial components of motion, it is now seen that both are efficiently in operation, though the circular dominates in intensity; so, while both the horizontal dynamic forces and the vertical convection are actively concerned in the structure of storm circulations, it is the former which preponderates, that is to say, local cyclones are but minor whirls in the general atmospheric circulation, which is continuously striving to reduce the difference of temperature of the atmosphere between the Tropics and the polar regions; also they are sometimes strengthened by the evolution of the latent heat of precipitation. The vertical currents in cyclones and anticyclones are primarily components of vortex motion, and these serve to set in operation the thermo-dynamic processes concerned in the making of clouds and rain or snow fall. The larger questions of meteorology concerning the slow seasonal variations, which depend upon special solar actions, and which mark the effect of solar energy expended in its most delicate and subtle forms, must require, like the large problems of astronomy regarding the structure of our solar system and the universe of stars, a considerable expenditure of labor and the lapse of no little time to arrive at an ultimate solution. Each generation has therefore imposed upon itself, in meteorology, as in astronomy, the duty of faithfully collecting observations of the phenomena as they occur in their day. In view of the distinct practical return which the Weather Bureau has been able to make to the public for the expense of its maintenance there has never been any disposition on the part of the people to omit to provide for such current scientific researches as the benefit of future generations seems to call for.

SOME EXAMPLES OF THE DEVELOPMENT OF KNOWLEDGE CONCERNING ANIMAL DISEASES.

By D. E. Salmon, D. V. M.,
Chief of the Bureau of Animal Industry.

INTRODUCTION.

The acquirement of knowledge in the domain of animal diseases during the century now closing has been constant and amazing, and compares favorably with the advancement in other branches of science which, with the zeal and activity of investigators, has attracted the wonder and admiration of the world. While something is known even to the general reader of the progress of knowledge in this field, and of the usefulness of this knowledge in explaining and preventing the diseases of man, there are comparatively few who have an adequate conception of the vast array of facts which have been accumulated and the revolution which these facts have brought in the prevailing ideas as to the nature of the various diseases and the methods by which they should be treated. To enter into all the details of the development of this subject during the century would require the writing of a series of volumes on the respective subdivisions, which, when completed, would be of professional rather than popular interest. A review of this character is manifestly impossible, even if such detail were desirable, in a Yearbook paper. The writer, therefore, deems it wise to confine himself to the work that has been done upon a few great problems which are, or should be, of interest to the many, and the elucidation of which has done most to ameliorate the condition of mankind as well as that of the domesticated animals.

The beginning of the nineteenth century almost defines the line at which the old and fantastic doctrines on animal pathology began to crumble and to be replaced by facts and scientific principles. Previous to that time a more or less elaborate system had been compiled, based upon observations made during the past history of the world; but as the ideas in regard to the structure and activities of the animal body were in many cases crude and erroneous, it is not surprising that the conceptions of disease were often distorted and strange, as viewed from the standpoint of our present knowledge. What is it that has brought light out of the darkness and order out of the chaos of the preceding centuries? What new factor, what change of method, was introduced with this century which accounts for the overthrow of the old doctrines that had been built up from the world's previous experience, and the substitution for these doctrines of definite and accurate knowledge? The answer to these questions is as interesting as the story of the achievements, and is of particular value at the present time. It should be a guide to us in directing the forces that will in all human probability make the twentieth century even more glorious in its accomplishments than the one which preceded it. The purpose of this paper is, therefore, not only to show the great strides of progress, but to indicate how this progress has been made.

INEFFECTIVENESS OF OBSERVATION WITHOUT EXPERIMENTATION.

It was in the early part of the seventeenth century that Bacon pointed out the weakness of the old speculative philosophy which built a great superstructure of doctrine or theory upon a foundation having a minimum of substantial fact and evidence. Such structures were without stability; they represented the individual workings of the philosopher's mind rather than the truths of nature, and for that reason they were constantly toppling over, to be replaced by another philosophic effort no more substantial than the first. Although Bacon at that time clearly demonstrated the necessity of first gathering all available facts and of interpreting these without preconceived bias by the inductive method, it was long before these teachings had their legitimate influence, either in human or veterinary medicine, and they are by no means universally accepted, outside of the scientific world, even at the present day.

The great question has always been, How are the facts relating to any branch of natural science to be obtained? The philosophers of the old school said, "by observation and deduction;" and they have their followers to-day who seek to direct, through legislative enactment, that physiological and pathological investigations shall be limited to "observation." But, if there is one great truth which stands out more prominently than others in the history of the progress of science, it is that observation, as contrasted with experimentation, is of itself insufficient to solve the problems or lead to an accurate comprehension of the facts.

EFFORTS TO DISCOVER THE CIRCULATION OF THE BLOOD BY OBSERVATION.

The insufficiency of observation without experimentation is demonstrated by the long-continued efforts to discover and explain the action and use of the heart, the arteries, the veins, and the blood. For hundreds of years the anxious students of physiology had made observations upon the living and the dead subject, but the mystery, ever elusive, had baffled the keenest vision. Thus, Hippocrates (460 B. C.) knew something of the movement of the blood. Aristotle (384 B. C.) taught that in man and the higher animals the blood was elaborated from the food in the liver, thence carried to the heart, and sent by this organ through the veins over the body. Praxagoras of Cos (341 B. C.) distinguished the arteries from the veins and regarded the former as air vessels. Erasistratus (304 B. C.) and Herophilus, of the Alexandrian school, taught that, while the veins carried blood from the heart to the organs of the body, the arteries carried a subtle kind of air or spirit. Galen (130 A. D.) discovered that the arteries were not merely air pipes, but contained blood. Servetus (1553) added to this knowledge the belief that the blood flowed from the heart to the lungs and from the lungs back to the heart. Thus, the studies and observations of two thousand years had only given a very incomplete and inaccurate idea of the circulation, leaving the great central fact of the heart's influence unknown and unsuspected.

HARVEY'S EXPERIMENTS FOR THE DISCOVERY OF THE MOVEMENTS OF THE HEART AND BLOOD.

It remained for Harvey (1578–1657), the great contemporary of Bacon, to elucidate the subject most thoroughly by a long series of experiments upon living animals. He tells us that he began his investigations into the movements of the heart and blood by experimenting and seeing the phenomena in living animals. He minutely described what he saw in pigs, dogs, serpents, frogs, and fishes. He even made use of slugs, oysters, lobsters, and insects, and lastly of the chick while still in the shell. He particularly described his observations and experiments on the ventricles, the auricles, the arteries, and the veins. He explained the mechanism of the valves in the veins, showing that their function was not to moderate the flow of blood from the heart, as Fabricius believed, but to favor its return to the heart. He clearly demonstrated the effect of obstruction of the blood stream in arteries and veins by the forceps in the case of a snake and by a ligature on the arm of a man. He proved that it is the contraction, not the dilation, of the heart that coincides with the pulse; that the pulse is not produced by the arteries expanding and filling themselves, but by the blood being forced into them and causing their enlargement; that there are no pores in the septum of the heart, and that all of the blood in the right ventricle is sent to the lungs and returned by the pulmonary veins to the left side of the heart, being forced again by the left ventricle into the arteries, round by the smaller veins into the venæ cavæ, through which it is brought back to the right side of the heart, making a complete circulation; that the blood in the arteries and that in the veins is the same blood; that the action of the right and left sides of the heart, auricles, ventricles, and valves, is the same, the mechanism in both being for the reception and propulsion of liquid and not of air; that there is no to-and-fro undulation in the veins, but a constant stream; that the dynamical starting point of the blood is the heart and not the liver. (Pye-Smith.)

All of these conclusions were revolutionary in their effect upon the doctrines of the times, and thus Harvey, by a few years of experimentation, completed the solution of this great problem, and contributed more in the way of definite facts to sustain his views and to clearly explain the phenomena of the circulation than had been furnished by all his predecessors from Hippocrates to his own time.

COMMENCEMENT OF SYSTEMATIC STUDY IN VETERINARY SCIENCE.

It was not until after the middle of the eighteenth century that veterinary schools were established and systematic instruction in animal pathology was commenced. Previous to that time there had been published some remarkable treatises on the diseases of animals, but the building up of the science may be said to have had its beginning at the foundation of the schools dedicated to the investigation and teaching of veterinary medicine. The first veterinary school was established at Lyons, France, in 1761; the second at Alfort, near Paris, in 1765. These were followed by one at Copenhagen, in 1773; Vienna, in 1775; Berlin, in 1790, and London, in 1791.

The beginning of the nineteenth century, therefore, found veterinary instruction in progress in the principal countries of Europe, and considerable literature suitable for text-books was already accessible. The study of the subject was stimulated not only by the establishment of the schools, but by the invasion of deadly epizootics, which had followed the course of the armies to all parts of the Continent and which threatened the annihilation of the domesticated animals. Knowledge of these plagues and the best means of controlling them had become essential to the existence of animal husbandry and the maintenance of the food supply. The accumulation of facts and correct views concerning these diseases was the greatest task of the veterinary profession, and the progress of this work is perhaps the best general indication that can be accepted in regard to the development of animal pathology.

GLANDERS AND FARCY.

One of the most terrible plagues of equine animals is called glanders when it affects the air passages and lungs, and farcy when it appears upon the skin. The principal symptoms are a discharge from the nose, ulceration of the inside of the nasal passages, particularly of the septum, enlargement of the glands under the jaw, and pustules of the skin. This disease, from which there is seldom recovery, was known to the Greek and Latin writers as one of the most serious diseases of horses and asses, and its contagiousness was quite generally admitted.

EARLY VIEWS REGARDING GLANDERS.

About 1749 the elder Lafosse, of Paris, began to teach the spontaneous origin of glanders, and endeavored to show from theoretical considerations and clinical observation that this was a purely local disease of an inflammatory nature and could not be contagious. At first this view was combated by many practitioners and by the veterinary schools, but being in harmony with certain medical doctrines it gained adherents, was taken up by the Alfort school, at first timidly and later with all the energy and eloquence of Renault, Delafond, and H. Bouley, and became predominant in France and perhaps also in Germany.

Renault thought that the disease might originate as a consequence of the absorption of pus from suppurating surfaces or abscesses, and this view was largely accepted. H. Bouley substituted the hypothesis that its origin was due to the exhaustion of the vital forces as a result of bad hygienic conditions or excessive work. Those who specified instances where the disease spread from an affected horse to others were met by the citation of instances where it did not spread. As H. Bouley afterwards admitted, the advocates of the hypothesis of noncontagion and spontaneous generation, by a singular disposition of mind, believed themselves authorized to invoke against the facts which proved contagion other facts where contagion did not result. This was the consequence of wrong methods of investigation and of improper use of evidence. Positive evidence establishes a fact: negative evidence can not overthrow positive evidence. It was by not understanding this apparently axiomatic proposition that the erroneous views in regard to the causation of glanders were so widely accepted and did so much harm.

The veterinarians of France, especially those of the army, were largely from the Alfort school, and, acting upon the teachings which they had received, they no longer treated glanders as a contagious disease, but permitted the retention of diseased animals and allowed these to be stabled with healthy ones without precautions to guard against communication. The inevitable happened, and the continental countries were overrun with glanders. The cavalry horses in particular were decimated, and thousands that became useless for the army were sold to civilians and served to propagate the contagion upon the farms, the very fountain head of the equine supply. From 1830 to 1840 the condition was almost intolerable, and the disease was becoming more and more prevalent. Those observers who believed the disease due to contagion were everywhere met by others equally sincere and able who believed it of spontaneous origin. It is a striking example of the difficulties of settling such questions by clinical observation alone.

EXPERIMENTS REGARDING THE CONTAGIOUSNESS OF GLANDERS.

In November, 1836, the French war department undertook to have the question of the contagiousness of glanders settled by experimental investigation. A commission was appointed, the members of which were mostly partisans of the doctrine of noncontagion, and evidently strongly biased, for after more than three years' investigation, in which 138 healthy horses were used, they were still unable to reach a decision. The minister of war then added to the commission a number of eminent men, members of the Academy of Sciences, who came with unprejudiced minds and a scientific spirit to the study of this important problem.

In 1837 an incident had occurred which had served to check to a certain extent the enthusiasm of those who denied the contagiousness of the disease. In this year Rayer recognized that a man who came under his observation was affected with a disease resembling glanders. Such cases, it appears, were not uncommon, but had been designated as putrid, or adynamic, fever. Investigation developed two facts of importance: First, the subject was a stable man, and as such had been intimately associated with horses; secondly, some of the horses which had been under his care were ascertained to be affected with glanders. This was strongly corroborative of Rayer's diagnosis, but it was not sufficient to meet the arguments of those who thought otherwise. Might not the occupation of the man and the presence of glandered horses be simply coincidences and without bearing upon the origin of the disease? It was necessary to prove the identity of the disease in the man with the well-known glanders of the horse. How was this to be done? Obviously not by disputation or by clinical observation, for these methods were incapable of reaching a definite and incontestable decision. There was but one course that had in it the promise of success, and that was experimentation. If the disease with which the groom was affected could be inoculated upon a horse, and if this horse developed the characteristic symptoms of glanders, then this would constitute a demonstration that the man was suffering from the equine disease. Fortunately for science and for humanity, this test was made. The liquids from the diseased regions of the man proved extremely virulent when inoculated upon the horse, and the disease which developed was glanders with all its well-known characteristics.

Rayer, who had investigated this case of glanders in man, was added to the commission of inquiry, as was also the well-known Boussingault. The strongest partisans of noncontagion were Renault and Magendie, both members of the commission. October 8, 1841, ten horses, carefully selected and perfectly healthy, were stabled with eleven other horses which presented the symptoms of chronic glanders. Each of the healthy animals was placed between two diseased ones, in order to intensify the contagion to which they were exposed, in case such contagion existed. Only eleven days had passed when four of the healthy horses presented symptoms which indicated that they had been infected. On November 22 there were only two horses remaining which did not show symptoms of infection. December 4 glanders with all its characteristics had developed in one of the horses, and by February 11 three more horses were in the same condition. As a result of about four months' close association nine out of ten healthy horses showed symptoms of glanders, and with four of these the disease was so fully developed as to be entirely characteristic.

The commission caused two of these horses to be killed, and on post-mortem examination found all the lesions of chronic glanders. The mucous membrane of the trachea and bronchi was covered with ulcerations, among which were found cicatrices, which Renault believed justified him in suspecting that the animals had been affected before the beginning of the experiment. However slight may have been the grounds for doubt, after the first experiment, it was decided that another test should be made. This was commenced April 11, 1842, with seven selected horses, which were placed two by two in the stables, so that each healthy horse would come in contact only upon one side with a glandered horse. By August 7 glanders had developed in every one of these experimental animals.

Just previous to these last-mentioned investigations, that is, in 1840, a special commission composed of officers of the different branches of the cavalry service, which had been charged to submit a plan of a model stable in which should be united the most advantageous hygienic conditions, made a report attributing the development of glanders among cavalry horses to the unsanitary conditions of the stables. An academic commission reported by the younger Bouley held the same opinion and thought that the bad construction of the cavalry quarters, the unhealthfulness of the stables, the crowding of the animals, and the vitiation of the atmosphere should be placed among the principal causes of what was called spontaneous glanders. Contagion, the true cause of the disease, was left out of consideration or given an entirely subordinate position, while attention was concentrated upon conditions which, at most, could but favor, to a certain extent, the propagation of the infection. Does not this bring to mind the contentions now being made by those who wish to find the cause of tuberculosis in some other agency than contagion and who invoke the influence of the identical conditions which the French military commission of 1840 found sufficient to explain the origin of glanders? H. Bouley, one of the most able contestants of the theory of contagion, and who afterwards frankly admitted his error, says in regard to the project for eradicating the disease by reconstructing the stables:

> If the certainty had been acquired, as it has been to-day, that contagion alone was the cause, and that to guard against it was sufficient to avoid the ruinous losses which glanders then occasioned, there is no doubt that the reconstructions proposed would not have been undertaken, or, at least, that they would have been upon a smaller scale and the expenses distributed over a larger number of years.

CONTAGIOUSNESS OF GLANDERS DETERMINED AND EFFORTS TO CONTROL THE DISEASE.

One other question remained to be solved. It was held by some that acute glanders might be contagious, while the chronic form, that usually encountered in the horse, could not be communicated. In the experiments which have been already mentioned the persons who held to this opinion thought that the contagion was explained by the disease having assumed an acute form in some of the animals to which exposure had been made. To answer this contention Saint-Cyr made a series of inoculation experiments, reported in 1863, from which he concluded:

> Under all its forms, in all its degrees, in all its conditions, in all its stages, and, finally, at every instant of its existence, glanders is contagious; and there is always danger of contagion, not possible, eventual, or conditional danger, but certain, actual, and always menacing danger.

This ended, in France, the contest over the contagiousness of glanders. A similar difference of opinion had existed in other countries, especially in Germany, but the problem was solved for all by experimental exposures to the contagion or by inoculation. Without these experiments upon living animals it is impossible to conceive how the views of those who interpreted differently the facts of observation could have been harmonized; and in the presence of doubt on the essential question of contagion or spontaneous origin, there was and always would have been hesitation and lack of thoroughness in applying preventive measures and in enforcing regulations for eradicating the disease.

After settling the question of contagion there were still two great problems which confronted the veterinarian in his efforts to control this disease. The first of these related to the cause of the disease; and while there was ignorance in regard to this it was impossible to have an intelligent comprehension of the conditions under which the contagion survived or of the kind and strength of disinfectants required for its destruction. This problem was solved simultaneously during the year 1882 by Bouchard, Capitan, and Charrin, in France, and by Loeffler and Schuetz, in Germany. Here, again, inoculation experiments were absolutely necessary to demonstrate that the suspected bacillus was the cause of the disease. Numerous forms of bacteria are usually obtained by making cultures from virulent material, and there is no way of learning which variety produces the disease except by making the trial, that is, by inoculating susceptible animals with a pure culture of each of these microorganisms. In that manner the bacillus of glanders, now known as the *Bacillus mallei*, was proved to be the active agent of the contagion, and the acquisition of this fact has brought with it a flood of light that has served to clear up the doubt and confusion of earlier years.

The second great problem was to find a speedy and certain method of diagnosing the disease. Glanders with horses is usually a chronic malady, which in its first stages presents very slight and indefinite symptoms that are entirely insufficient to enable the observer to state positively that the animal is affected with this dangerous and fatal disease. Nevertheless, the disease is contagious at that period and is liable to be disseminated to other horses and to the attendants; indeed, it is the animals that have failed to develop characteristic symptoms which are most dangerous, since very often they are not even suspected as sources of contagion. Sometimes affected horses live for several years in this condition, and attention is only attracted to them finally because a series of horses which have been exposed to them have successively developed the disease. Even after such horses were suspected it was a most difficult and embarrassing matter for the veterinarian to produce sufficient evidence to warrant their destruction, particularly if they happened to be valuable or if the owners were attached to them. This difficulty of diagnosis was largely responsible for the continuance of the contagion, and it was especially felt in large stables containing many horses and where it was consequently essential to successful treatment to have every affected animal removed.

The first efforts to aid clinical observation in making a diagnosis were by inoculation. Either the suspected horse was inoculated with its own nasal discharge (auto-inoculation) or another individual of the equine species was used for this purpose. Very often satisfactory evidence of glanders could be obtained in this way, but in far too many cases the results were uncertain or unreliable. With the bacteriological studies and the inoculation of small animals came the knowledge that the guinea pig was very sensitive to this contagion, and that, if inoculated in a proper manner, it would present characteristic symptoms in a few days. This was an extremely valuable discovery, and where only one or at most a small number of horses were suspected, it made it possible for the veterinarian to reach a quick and reliable decision.

JUSTIFIABLENESS OF INOCULATIONS IN GLANDERS.

The question is now raised as to whether these inoculations are justifiable, and the antivivisection societies, with many of the humane societies, have joined in an effort to secure legislation to make it a criminal offense to conduct such experiments upon living animals. The ethical questions relating to the alleged wrong of causing suffering to an innocent guinea pig, either for the advancement of science or the diagnosis of a disease, are too broad to receive more than a mere mention in this connection. It may be admitted, however, that so long as we acknowledge the right and the morality of raising animals to be slaughtered for food, and so long as we permit such a painful operation as castration to be performed on millions upon millions of individuals to make them more docile, to cause them to fatten more readily, to improve the quality of the meat—in a word, for the financial profit which arises from the operation—it is inconsistent to deny the propriety of a method of experimentation which in the aggregate has saved much more distress than it has caused and which is essential to the advancement of medical knowledge. In the case which has just been mentioned, for instance, it may be asked whether the practitioner would be justified in leaving a horse suspected of glanders to come in contact with other animals, perhaps to communicate the disease to some human being, when he could definitely decide the question by inoculating two or three guinea pigs. It might be said that a suspected horse should be put in quarantine in order to prevent such untoward consequences, but there are all degrees of suspicion, and a horse can not be quarantined under the law and his owner put to expense and loss without some evidence. It is a question of danger and suffering with men and horses on the one side and with guinea pigs on the other. Under such circumstances the objections appear unworthy of serious consideration.

THE MALLEIN TEST FOR GLANDERS.

Fortunately, a continuation of the experiments with living animals has led to a discovery which largely does away with the necessity of inoculating guinea pigs or other creatures in order to make a diagnosis in the doubtful cases to which reference has been made. In cultivating the bacillus of glanders it was observed that it produced during its growth a toxic substance which, when injected into the tissues of an animal affected with glanders, caused a local swelling and raised the body temperature to such a marked extent as to be of great assistance in making a diagnosis. This toxin is called mallein, and the experiment of injecting it for the purpose of making a diagnosis is called the mallein test. It is particularly useful in cases where a large number of horses which are stabled together have been exposed, and where it is, consequently, of the utmost importance that those which have become infected shall be recognized and removed at the earliest moment. It may not be quite as accurate a test as the inoculation of guinea pigs, but it is more expeditious, less expensive, and saves the guinea pig from dying of glanders, though it may eventually die of some other disease equally painful, even if it does not contract it by inoculation.

In addition to the investigations to which reference has been made, there have been many others yielding much information in regard to the pathological anatomy, histology, and pathology of glanders which for want of space can not receive consideration.

VARIOLA (COWPOX, HORSEPOX).

Some time during the sixth century there was introduced into Europe one of the most horrible and fatal diseases from which mankind has ever suffered. This disease, now known as variola, or smallpox, is no longer greatly feared, but at that time and through the middle ages, and in fact down to the beginning of the nineteenth century, it was a scourge that could neither be avoided nor conquered. Practically every adult person's face showed the scars. One-tenth of the deaths were caused by it. In England in 1796 the death rate reached the highest point, being 18½ in every 100 deaths from all causes. No city or district was long free from it. People exposed themselves to it or were inoculated with the contagion in order to have an attack under as favorable circumstances as possible, and thus secure immunity for the future. Inoculation was of some benefit—often produced a comparatively mild form of the disease and gave immunity; it had the great disadvantages, however, that it frequently caused a fatal attack, and, in all forms, it kept up and spread the contagion.

JENNER'S DISCOVERY OF A PREVENTIVE OF SMALLPOX.

In 1798 Edward Jenner announced his discovery that smallpox might be prevented by inoculation with the virus of cowpox, and that cowpox was identical with a disease of horses known by the farriers as grease, or sore heels. This discovery has been of such enormous advantage to humanity, and there have been so many questions raised relative to the nature of the so-called grease of horses, from which cowpox originates, that it is of unusual interest to inquire how Jenner's discovery was made and what developments in our knowledge of the disease have since occurred.

There is no doubt that there was a popular belief in Jenner's native county of Gloucestershire, England, to the effect that the men and women who milked the cows and who developed the vesicular eruption of "the cow disease," would not afterwards contract smallpox. To what extent this belief was held in that section of England, and whether it existed in other countries, are subjects in regard to which there is little reliable information. It is certain that those physicians of the period who had heard of the belief regarded it as due to an erroneous interpretation of facts, but Jenner's conclusions were accepted so promptly that we are justified in concluding that the skepticism and opposition were not greater than might reasonably be expected toward a similar discovery at the present day.

As an indication of the wonderful change which has been brought about since the introduction of vaccination, the writer has taken the latest mortality statistics compiled by the Marine-Hospital Service, based upon the returns from 1,597 cities and towns in the United States, for the year ending December 31, 1897. The population covered was 22,472,334, the total number of deaths 338,994, the number of deaths from smallpox 44, being in the proportion of 1 to 7,704.

How did Jenner make this discovery? How did he determine that the belief of certain people of his county in the protective power of the cowpox eruption against the dreaded smallpox was more worthy of credence than the opinion of others that it did not have this effect? He accomplished this in the only possible way—by experimentation. A boy was vaccinated from a pustule upon the hand of a milkmaid which had been contracted in milking affected cows. The vaccination produced the pustule so well known at the present day, as the result of this operation. After recovery from the vaccination the boy was inoculated with smallpox virus, an operation then very common in England. From this inoculation there were only the effects usually seen following the inoculation of persons who had recovered from an attack of smallpox.

Jenner went a step further and inoculated another child with virus taken from a pustule upon the teat of a cow in an outbreak of the so-called spontaneous cowpox. This child also developed a pustule at the point of inoculation, with slight general symptoms of illness. Starting from this child many arm-to-arm inoculations were made, proving the characteristic appearance of the disease and that it could be propagated indefinitely.

Jenner also cited the case of a farrier who, in caring for horses affected with a disease called grease, had contracted an eruption of the hands with ulceration and suppuration that was accompanied with quite severe illness. Six years later Jenner inoculated this man at different times upon the arms with smallpox virus and only succeeded in producing slight inflammation, which soon disappeared. An identical observation was made with a farmer who had contracted an eruption by taking care of a horse having this disease of the pasterns called grease. It was also observed that when the horses having this eruption were cared for by the same men who milked the cows the disease was carried by these men and caused the eruption of cowpox.

ORIGIN OF COWPOX.

The belief of Jenner that cowpox originates from the inflammation of the skin of the horse's pastern, properly known as grease, has been generally accepted, and we still find the statement in medical works that grease, or equinia mitis, is the origin of cowpox. Now, what is this grease which is communicable to the cow, and from the cow to man, granting such remarkable immunity from smallpox? The disease known to the veterinarian as grease is a more or less aggravated inflammation of the skin of the heels and adjacent parts of the horse, with cracks and fissures, from which there is an offensive discharge, which looks greasy, but which is really a serous exudation. This inflammation may increase until the whole surface is ulcerated and covered by fleshy excrescences slightly resembling grapes in form, and in this stage was popularly called "the grapes." This disease arises from irritation due to moisture, mud, and filth in contact with the skin of the lower part of the limbs. It is not contagious; inoculation from it produces nothing resembling the vaccine vesicle, and for many years it was a mystery how Jenner could have found in this local and spontaneous disease the origin of cowpox.

In 1802 Dr. Loy, of England, published an "Account of some experiments on the origin of cowpox," in which he stated that the horses which communicate the eruption to the men who groom them have at the commencement of the disease symptoms of fever and marked indisposition, which subsides after the appearance of an eruption upon the heels and upon the skin of the greater part of the body. Loy, desiring to confirm the experiments of Jenner, did not hesitate to inoculate his own brother, with the result that after a few days inflammatory symptoms appeared, followed on the eighth day by a vesicle, with slight symptoms of fever, which continued for a day or two. This eruption had precisely the characters of the true vaccine.

In another experiment Loy inoculated the udder of a cow with clear lymph taken from the heel of an affected horse, which produced a characteristic vaccine vesicle. The limpid fluid from the vesicle on the cow's udder was used to vaccinate a child, and produced a vesicle which completely protected from an inoculation with smallpox virus made on the ninth day. Loy also inoculated directly from the vesicle on the horse to the arm of a child, and successfully produced the vaccine vesicle. From this child three other children were successfully inoculated, and their immunity was afterwards tested by inoculation with smallpox virus. With none of them did the smallpox inoculation produce more than a very slight inflammation, which disappeared by the fifth day.

This extremely valuable work of Loy's appears to have been lost sight of for many years, and veterinarians and physicians sought in vain in the various local affections of horses' feet for the virus of cowpox. Chapped heels, grease, and even fistulas furnished material for unsuccessful inoculations, and some of the ablest men of the first half of the century absolutely denied that cowpox could originate in this manner. This opinion was due to the failure of Jenner to describe the disease of horses from which the virus was obtained, and to the ignorance of the farriers, which led them to confound widely different diseases under the one name of "grease." Loy's description, in which he clearly points out the general symptoms preceding the eruption with the horse, and the appearance of vesicles on various parts of the surface of the body, should have been an indication of the cause of failure, but did not attract attention at the time.

The great veterinarians of England, including Coleman and Percival, denied the existence of a disease of horses which could be communicated to cows and produce cowpox, and it was not until sixty years after the observations and experiments of Jenner and Loy that the mystery was cleared up and the facts demonstrated.

The rediscovery of the variola of the horse was largely accidental.

In the spring of 1860 a number of horses near Toulouse, France, were affected with a disease which seemed to be of an epizootic character; in less than three weeks it appeared in more than a hundred animals. According to Sarrans, the veterinarian in charge, this disease began with a slight fever, soon followed by swelling of the hocks, with heat and tenderness of the skin, and the appearance of many little pustules on the surface of the swollen parts. In three to five days a purulent discharge began, which lasted eight or ten days, during which the inflammatory symptoms gradually disappeared. After this second stage the pustules gradually became dry, and from the fifteenth day the crusts and matted hair began to fall, leaving scars of variable development. The pustules did not appear on the limbs only, but also upon different parts of the body, particularly about the nose, lips, thighs, and vulva.

Sarrans did not recognize in this disease the "grease" of Jenner, but he did observe its contagious character. No cows were affected, because the persons taking care of the horses did not engage in milking, and there was no opportunity for transferring the contagion. It is, therefore, probable that the nature of the malady would not have been discovered had not one of the affected horses been taken to Professor Lafosse, of the Toulouse veterinary school. At the first visit only febrile symptoms could be made out, but eight days later the animal was suffering from lameness, with swelling of the left posterior pastern, which was hot, painful, and covered with pustules, discharging an ammoniacal liquid less fetid than the exudation of grease.

It occurred to Lafosse that this was the acute form of grease, and probably the disease to which Jenner had traced the origin of cowpox. He therefore inoculated the udder of a cow with this equine discharge, which he believed was the product of the initial period of grease (eaux-aux-jambes). The success of this inoculation was complete, and in eight days a pustule appeared at each point where the virus had been inserted. These elevations were large, flat, firm, and circular, with a central depression. There could be no mistake; these pustules were the cowpox of Jenner, drawn from their equine source, and they confirmed the accuracy of the conclusions of that eminent investigator.

In order that the demonstration might be complete, a second cow was inoculated from the pustules of the first, causing a typical cowpox eruption, which was in turn inoculated successfully upon a child and a horse. A second child was inoculated with virus taken from this horse and developed a typical vaccine vesicle. Finally, comparative inoculations were made with virus of equine origin and with the ordinary vaccine, which demonstrated that the former produced larger and better developed vesicles, but which were slower in their evolution than the latter.

HORSEPOX.

There was here satisfactory experimental demonstration that this horse disease was identical with cowpox, but what was the horse disease? Lafosse at first considered it the early stage of the acute form of grease, but as it developed he observed the confluent pustules developing upon the pasterns and fetlocks, and afterwards disseminated over other parts of the body, particularly upon the lips and nose. This differentiated the affection from grease and proved it to be a specific eruptive disease. It was now plain why there had been failure for so many years to obtain the cowpox vesicle by inoculating with the discharge from greasy heels and fistulas of the feet. Two entirely different and distinct diseases had been confounded under the same name.

These unexpected results obtained at Toulouse led H. Bouley, of the Alfort veterinary school, to undertake, in 1863, the inoculation upon the cow of all eruptive diseases of the horse which by chance came under his observation in his daily clinics. Strangely enough, the very first disease that he inoculated produced a clearly defined case of cowpox. What was this disease of the horse? It could not be designated "sore heels," since it was localized in the head, and consisted of small blisters, the size of a pea, upon the mucous membrane of the lips, the lower surface of the tongue, the inner face of the cheeks, and the gums. There was no trace of the eruption except within the mouth.

During the next few months this horse disease, which was capable of generating cowpox, appeared in the clinics of Alfort under all the various forms which it is capable of assuming. At one time localized in the pasterns, as seen by Jenner, at other times affecting the hocks, the general surface of the body, the nose, or the internal surface of the mouth; it at first appeared inexplicable that all of these different manifestations of disease should produce cowpox when inoculated upon the udders of bovine animals. "If I was able to recognize the specific nature of the disease," says Bouley, "it was owing to the course that I had adopted of interrogating by inoculation all the eruptive diseases of the horse that the chances of the clinic brought under my eyes."

When all the evidence from these and other inoculation experiments was brought together, it became plain that what had been regarded as a number of distinct diseases was in reality but one and the same contagion affecting different parts of the horse's body. When this contagion was transferred from animal to animal by the shoer in handling the lower part of the limbs, the eruption was usually confined to the pasterns and fetlocks. When the communication was by means of the currycomb and brush, the pustules were disseminated over the surface of the body, but appeared particularly where the skin was thinnest and the virus most easily introduced, as upon the neck, thighs, and hocks. When the animal contracted the disease by smelling of affected individuals or rubbing its nose against them, the eruption very naturally occurred upon the skin of the lips and nose and upon the mucous membrane of the interior of the nostrils. When the virus was taken into the mouth with contaminated forage, the vesicles appeared upon the mucous membrane of the lips, tongue, and cheeks. And, finally, when the contagion was communicated by the act of copulation, the eruption was seen upon the external organs of generation. To this specific disease, which appeared under so many forms, H. Bouley gave the appropriate name of horsepox.

RELATION OF SMALLPOX, COWPOX, AND HORSEPOX.

Whether the virus of this disease is taken from the horse or cow and inoculated upon a susceptible human being, it produces substantially the same effects—a characteristic vesicle with regular course of development, which confers immunity, more or less complete, from smallpox. This remarkable result has raised the question as to the relation which exists between smallpox, on the one hand, and horsepox and cowpox, on the other. Are these essentially one and the same disease, due to contagion of the same origin, but which has been modified by developing in different animal species for a series of generations? or, are they distinct, different, and incapable of being changed one into the other? There have been many investigations made with a view of settling this question, which have been variously interpreted, but for most pathologists it is probably still held as undecided. The experiments upon animals as well as upon mankind prove that cowpox grants immunity from smallpox and smallpox from cowpox; and it is, therefore, reasonable to conclude that they are closely related, if not identical, in origin. It has, however, been shown to be very difficult, if not impossible, to transform smallpox into cowpox by inoculating the virus upon a series of bovine animals, and in the few cases where it is supposed that this was accomplished there are reasons for doubting the correctness of the conclusion.

EXPERIMENTAL INOCULATIONS UPON ANIMALS AND CHILDREN.

What strikes the student of methods as most conclusive in the history of the development of our knowledge of variola is the prominence of experimental inoculations upon animals and children. The clinical observer had problems presented to him which he was unable to solve by observation alone, and in order to clear up the mysteries and obtain light he was obliged to combine experimentation with observation. There are those, no doubt, who will be horrified by the references to these experiments upon children, but it should be remembered that at that period smallpox was the great destroyer of children; that they were frequently and purposely exposed to it or inoculated with its virus in order that they might have an attack at a favorable time and obtain immunity. Smallpox inoculation, if not as common as the vaccination of the present day, was certainly very largely practiced. Under such circumstances, the inoculation of children with smallpox virus, after they had been vaccinated with cowpox, is no more to be condemned than the general practice of inoculation, which before the discovery of vaccination was so widely adopted and so useful as a prophylactic measure.

CONTAGIOUS PLEURO-PNEUMONIA OF CATTLE.

SPREAD OF PLEURO-PNEUMONIA.

In the early part of the eighteenth century there began to appear accounts of an acute lung disease of cattle, which affected these animals in the mountains of Suabia and Switzerland. This disease very slowly extended to adjacent parts of Germany, Italy, and France, and in 1769 the first really important investigation was made of it in France by Bourgelat, the founder of the veterinary schools, who published an excellent account of his observations. Bourgelat described what he saw—the symptoms, the appearance of the diseased organs, the course of the disease, and its fatal character. He considered that the cause was atmospheric variations, cold and abundant rains, to which the animals were exposed, and sudden passage from warm stables to such rains. There is no evidence that he suspected contagion.

During the wars of Napoleon the disease was considerably spread over Continental Europe, but it was not until the increased traffic and interchange of animals, which dates from about 1820, that its general dissemination occurred. From 1820 to 1840 it extended into most parts of France and Germany. In 1826 Belgium was infected; in 1833 it reached Holland; in 1839 it was carried from Holland to Ireland; in 1841 or 1842 it reached England, and from there was exported to Sweden in 1847. The contagion was brought to the United States with imported cattle in 1843. It was carried to Spain in 1846, to Denmark in 1848, to South Africa in 1854, and to Australia in 1858.

During all of these years there was a constant discussion and contest between the clinical observers as to whether the disease was of spontaneous origin or whether it was due to contagion. Haller, in 1773, expounded the doctrine of contagion with a clearness and force that is surprising, and stated that even in Switzerland, the home of pleuro-pneumonia, this disease does not arise except by contagion. In 1792 Chabert published his "Instruction sur la peripneumonie," in which his great influence was thrown with those who believed in contagion. Nevertheless, from 1800 to 1850 the conclusion that pleuro-pneumonia was not a contagious disease steadily gained adherents. During this long polemic and period of uncertainty, sanitary regulations were neglected, the plague spread to all parts of Europe, and even invaded America. Before the experimental proofs of contagion were generally accepted the disease had been carried to the African and Australian continents, and practically the whole cattle-producing world was infected.

This brief history of the invasion of a large part of the world by one of the most serious and fatal forms of contagion demonstrates again the impossibility of determining such pathological problems by mere observation, and yet we are told by those who oppose experimentation upon living animals that the investigator must not experiment, but must confine himself to clinical observation. Let us see how the question as to the contagiousness of bovine pleuro-pneumonia was finally solved.

INVESTIGATIONS OF PLEURO-PNEUMONIA IN EUROPE.

In 1850 the prevalence of the disease had become so serious that Dumas, then minister of agriculture, commerce, and public works of France, appointed a commission to investigate its nature and cause. This commission at once proceeded to test the contagiousness of pleuro-pneumonia by experimentation. To determine the question as to whether the disease could be communicated from a sick to a well animal, they adopted the plan of introducing sick animals into a stable of healthy ones and noting what followed. The result of this experiment was that 50 per cent of the exposed animals contracted pleuro-pneumonia—15 per cent died and 35 per cent recovered. In addition, 30 per cent of the exposed animals contracted a cough indicative of a very mild form of the disease, while 20 per cent appeared to entirely resist the influence of the contagion. It is this 20 per cent, remarked H. Bouley, which furnished the facts upon which rest the arguments of the noncontagionists.

In Great Britain there was a similar difference of opinion on the subject of contagion, and as late as 1859 an article was published in the Transactions of the Highland Agricultural Society of Scotland, written by Professor Dick, principal of the Edinburgh Veterinary College, in which he tried to prove that pleuro-pneumonia is produced by atmospheric causes, but not by contagion.

A commission appointed in Prussia to investigate the cause and method of transmission of this disease reported in 1852, through Ulrich, that it was certainly contagious.

Notwithstanding this and much other experimental work, there were many in all countries who refused to accept the evidence, and, basing their conclusions upon clinical observation, they insisted that the disease was of spontaneous origin and not due to contagion. This contest over the cause of the disease led to intense opposition to suppressive measures and permitted the continued spread and destructive effects of the contagion. In Australia the contagion might have been stamped out if proper measures had been promptly enforced, but this seems to have been prevented by the obstinacy and active opposition of the noncontagionists. A pleuro-pneumonia commission was appointed to investigate the question of contagion, and while the commission investigated and gathered observations to establish the noncontagiousness of the disease the contagion leaped beyond the possibility of control, and to this day (1899) its ravages unfortunately continue among the herds of that great cattle-producing continent.

The members of the Australian commission were to a man noncontagionists, and they labored with all the strength of a preconceived opinion to prove their side of the controversy. They fetched healthy cows from Tasmania, where pleuro-pneumonia had never been, placed them in stalls beside diseased animals, inoculated them in various crucial ways, and then declared their inability to communicate the fever by contagion. They reported the result to the legislature, and based upon their failure an advice deprecating any further legislative interference. And yet the Government printer's ink was hardly dry upon their report when a counter report came from the butchers of Geelong, who had bought for slaughter the experimental bullocks, that the animals were all diseased, unfit for human food, and demanding back their money.[1]

While the methods of this commission can hardly be taken as a model in all respects for scientific investigations, the evidence finally obtained from their experiments was nevertheless convincing, and, although the critical period when the disease might have been stamped out was allowed to pass without decisive action, the contagiousness of the disease is no longer seriously contested.

INVESTIGATIONS OF PLEURO-PNEUMONIA IN THE UNITED STATES.

In the United States the experience with pleuro-pneumonia was almost parallel with what occurred in Australia. Introduced in the vicinity of New York City in 1843, the disease appears to have been regarded as due to climatic conditions rather than contagion, and was allowed to slumber without attracting much attention until it was investigated by Gamgee in 1868 and 1869. In the meantime an importation of cattle from Holland had carried the disease to Massachusetts in May, 1859. Although the nature of the disease was recognized and brought to the attention of the legislature, the contagion was allowed to spread for a year before authority was granted for its suppression. It was then necessary to slaughter 932 animals to dispose of all that were known to be exposed.

A year later it was found that some affected animals had eluded the commission and that the disease still existed. There now began a most remarkable series of delays, obstructions, and efforts on the part of misguided persons to prevent the eradication of the plague. Commissioners were appointed who did not believe in the existence of a contagious disease. The governor directed that experiments be made

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[1] Veterinarian, 1875, p. 681.

to test the question of contagion, and, as so frequently happens where scientific methods are not used, these were unsatisfactory. In 1864 the board of commissioners had again been reorganized and experiments were still in progress to test the contagiousness and curability of the disease. In 1865–66 it was stated that the commissioners had been so far successful that but few cases had occurred during the year. The experiments also seem to have had positive results, as it was reported that of six animals exposed four had certainly contracted the disease. In the report for 1866–67 the commissioners announce the extinction of the disease, the last cases having occurred in October, 1865.

The contagion which was imported at New York was, however, allowed to exist and spread until, in 1879, an effort was made by the States of New York and New Jersey to eradicate it from their territory. At this time the infection existed in Connecticut, New York, New Jersey, Pennsylvania, Maryland, District of Columbia, and Virginia. The efforts of the States were not well sustained and resulted unsuccessfully, though they served to attract attention to the danger which constantly menaced our cattle industry. The realization of this danger led Congress in 1884 to establish the federal Bureau of Animal Industry, the principal object in view being the investigation of the disease and the adoption of measures for its control.

There has been much skepticism expressed by influential persons as to the existence of pleuro-pneumonia in the United States, and doubt as to its contagious character in case the disease were found. Opinions of this nature were so freely declared that the Commissioner of Agriculture deemed it advisable to direct an experiment to be made which would once for all settle these questions. According to his instructions, new stables were erected upon an island easily accessible from the city of New York. There were but fifteen native cattle upon this island, and there was no history of any disease ever having appeared among them. When the stables were completed eighteen cows and thirteen calves were brought direct from Canada, a section where no disease having symptoms at all simulating those of pleuro-pneumonia had been observed, and were placed in the stables erected for this experiment. These animals were thoroughly examined by experts and found to be entirely healthy.

It was believed that by selecting an island where no lung disease of cattle had been known, in building new stables on well-drained land, and in bringing healthy cattle from a country where the disease had never been observed, the conditions of the experiment were such that the results would be absolutely reliable. To expose these animals in such a manner as to test the contagiousness of the malady, five cows selected in the city of Brooklyn as being affected with contagious pleuro-pneumonia were placed in the stable with the healthy Canadian cattle. As a result of this exposure by close association, twenty-two of the thirty-one experimental animals contracted pleuro-pneumonia between September 30, 1884, and January 3, 1885, a period of less than three and one-half months.

This experiment was convincing as to the existence and contagiousness of the disease. Within a comparatively short period 71 per cent of the exposed animals had become affected, and with a number of these the attacks were very acute and typical in symptoms and development, while the appearances of the lungs after the death of the animals were perfectly characteristic.

SUCCESS OF EXPERIMENTAL EXPOSURES AND INOCULATIONS.

This ended the experimentation with pleuro-pneumonia in the United States and furnished an incontestable basis for the rigorous sanitary measures which led to the final eradication of the contagion. What must appear to every reader as remarkable is the doubt as to the contagiousness of the disease which was so tenaciously held in every affected country. It appears as though clinical observation led more people to erroneous conclusions than to correct ones. And where such differences of opinion resulted from observation, how was the truth to be known? In every country the resort was finally to experimental exposures and inoculations, and the results of these have been clear and satisfactory. The measures formulated in harmony with the conclusions drawn from the experiments have been successful in extirpating the disease from the United States, Great Britain, and other countries, and the question of its contagiousness appears forever settled.

There have been numerous other questions that have been investigated, and the effort to discover the active agent of the contagion has been persistent and thorough. It has long been known that the serum, or exudate, of the diseased lung was virulent, and it has been extensively used for inoculation with the purpose of conferring immunity. The microscopic examination of this serum and the attempts to make cultures from it by the ordinary bacteriological methods failed to reveal any microorganism, and it is only recently that apparent success has been obtained by making such cultures in collodion capsules placed in the abdominal cavity of an animal a sufficient time for multiplication to take place. The microorganism obtained was much smaller than any previously discovered and could not be defined with existing powers of the microscope.

ANTHRAX (OR CHARBON).

Accounts have come down to us from the earliest historical times of outbreaks of a plague affecting man and most species of animals which are identified by students of this subject with the disease now known as anthrax, carbuncular fever, malignant pustule, or charbon. Whether the plague described by Homer in the first book of Iliad and the sixth plague of the Egyptians were or were not manifestations of anthrax may be open to some question; but by the beginning of the Christian era the descriptions became so clear that there is no reason to doubt the prevalence of anthrax at that period with substantially the same characteristics as it presents at the present day. During the long period of the middle ages frequent outbreaks are noted, which, with the revival of learning and the increasing attention given to professional studies, were more often mentioned. The eighteenth century is remarkable for the large number of epizootics of this nature which occurred in Europe.

EARLY DESCRIPTIONS OF ANTHRAX.

As might be expected, the diagnosis at that period was far less accurate than to-day, and it is not difficult to perceive that widely different diseases were sometimes confounded under the single term of anthrax. Thus, rinderpest was confused with anthrax during the eighteenth century and as late as the second quarter of the nineteenth, while blackleg, or symptomatic anthrax, and malignant œdema have only been differentiated from it in recent years by bacteriological researches.

Chabert (1782) gave the first systematic description of the disease and pointed out the symptoms which were peculiar to it. He described three forms: (1) Anthrax fever, or internal anthrax, characterized by fever without external swellings; (2) essential anthrax, manifested by external swellings without preceding general symptoms; (3) symptomatic anthrax, characterized by fever followed by external swellings. The dark color of the blood and flesh, together with the severity of the symptoms, and the rapid course and fatal termination, were characters recognized from the earliest antiquity.

INVESTIGATIONS REGARDING THE CAUSE OF ANTHRAX.

As there are numerous and extensive districts where anthrax has been endemic and enzootic from time immemorial, and as it attacks nearly all varieties of animals and is readily contracted by man in caring for diseased animals, skinning carcasses, making post-mortem examinations, eating the infected flesh, handling the skins, or sorting the wool, the great number of cases attracted much attention and led to constant efforts to discover the cause. The various investigators attributed the origin of the disease to about every condition to which the animals could possibly have been exposed. Some taught that it was due to small, badly ventilated, and unsanitary stables; others that it was caused by food of bad quality, forage and grain too recently harvested, or covered with rusts or molds; still others attributed it to the herbage of artificial pastures, clover, lucern, and corn; yet another class found its origin in atmospheric conditions, such as excessive heat and moisture; while, finally, there were those who, rejecting all of these conditions, found what they believed to be the true cause in the conditions of the soil, that is, in the moisture, the clay, and the lime, which were believed to coincide with the areas in which the disease was enzootic.

Renault and Reynal, authors of the article on charbon, in the "Nouveau Dictionnaire de Médecine, de chirurgie et d'hygiene vétérinaires," writing as late as 1857, after recapitulating these various theories, naively admitted that "the causes which give birth to anthrax are still enveloped in a certain obscurity, in spite of the researches of which they have been the object. Perhaps, even, it is true to say that this obscurity results from the large number of these researches and the different points of view of the observers who sought to study this disease. In fact there are almost as many special and different causes which have been assigned to it as there are particular treatises on the subject. It is here, above all, that the old aphorism is true: Quot homines, tot sententiæ [minds as many as the men]."

Nevertheless, from the beginning of the century physicians had observed that certain malignant pustules in man originated by accidental inoculation from animals affected with anthrax, or from their carcasses, and Barthélemy, in 1823, succeeded in producing the disease in horses and sheep by inoculation and feeding with anthrax blood. The following year Leuret communicated the disease by transfusion of blood from a diseased to a healthy horse.

These positive results were explained away by comparing them with the effects which follow inoculation with putrefying animal matters, and the most that was gained was the assumption of the putrid nature of the anthrax virus.

In 1836 Eilert obtained infection in every case by inoculation of blood from sheep to sheep, from sheep to horses, and from cows to sheep. The feeding of clover hay which had been moistened with infectious blood and afterwards dried in the sun killed two sheep out of three.

One of the studies of this disease was made in 1842, under the direction of the French minister of agriculture, by Delafond, an exceedingly able professor of the Alfort veterinary school. There had been for many years an enzootic disease affecting the sheep of La Beauce, province of Eure-et-Loir. This is a district with fertile soil, favorable to animal production, and where sheep are raised and fed in large numbers. There was but one obstacle to the maintenance of this industry in a prosperous condition—the presence of the disease known as sang, coup de sang, maladie de sang, or sang de rate, which destroyed 20 per cent of the animals annually. The first fact observed by Delafond after reaching this section was that the disease most frequently attacked the animals which were youngest, which had been thriving in the highest degree, and which promised to be the best in the flock. Considering this fact in connection with the fertility of the soil, the abundance and the quality of the crops, and the liberality of the feeding, Delafond reached the conclusion that the disease was only a condition of plethora, an excess of blood circulating in the veins, and, above all, a predominance of red globules in this liquid. He analyzed the soil, proving its fertility favorable to the production of forage rich in nutritive principles; he analyzed the blood, showing this to contain a high percentage of albumin, fibrin, and red globules; he analyzed the plant food and found this, as he predicted, having a high nutritive value; he examined the sick animals and the carcasses of the dead ones, finding the distended blood vessels, the thickness of the blood, the frequent hemorrhages, the swollen spleen, the congestion and dark color of the other organs, all apparently uniting to establish his theory that the disease was plethora, caused by too rich and too abundant food. The frequent development of malignant pustules in persons who handled the dead carcasses or their products he explained as due to a septic or anthracoid alteration of the blood, resulting from insufficient ventilation of the stables and the inhalation of putrefactive gases.

H. Bouley afterwards remarked concerning the above report:

Nothing proves better than this document, remarkable for the logic of its deductions, but the premises of which were a fundamental error, how difficult it is to seize and interpret the relations of things when one has no other basis for judgment than that which observation alone can furnish. Delafond had found a part of the truth when he established a relation between the food supply and the aptitude of the sheep to contract the disease. But observation could not conduct him further and give him an accurate notion of this maladie de sang. It was necessary to resort to experimentation, and it was because he did not invoke this method that his researches led him into error, and that he only saw plethora in this disease of La Beauce, the identity of which with anthrax was soon afterwards recognized.

It was but ten years later (1852) that Boutet read before the Academy of Medicine of France a report of an experimental study of this disease of La Beauce. He showed that the disease might be communicated by inoculation, by transfusion of blood, by direct contact, and exceptionally by cohabitation. It was not only communicable to sheep, but to horses, cattle, and rabbits. The sang de rate of the sheep, the sang, or anthrax fever, of cattle, the anthrax fever of the horse, the malignant pustule of man were shown by these inoculation experiments to be one and the same disease. It was also shown that the contagion resided in all the organs and liquids of the body and that it might be inoculated from animal to animal indefinitely without losing its virulence. Here at last was something definite and tangible in regard to this disease, a foundation of fact upon which to build by future researches.

In 1845 and 1846 Gerlach had published papers giving accounts of further experiments proving the contagiousness of anthrax and showing the persistence of the contagion in the soil three years after the burial of carcasses of animals dead of this disease. In 1850 Rayer and Davaine called attention for the first time to the presence in anthrax blood of small filiform bodies, in length about twice the diameter of a blood globule and without spontaneous movements. In 1855 Pollendar stated that he had observed since 1849 the little rods mentioned by Rayer and Davaine, and that they possessed the histochemical reaction of a vegetable substance. He was unable to determine whether there existed any relation between the presence of these bodies and the virulence. These rod-like bodies were again mentioned by Brauell in 1857, who not only observed them in the blood of men and animals which had died of anthrax, but saw them in the blood before death, and concluded that their presence confirmed the diagnosis and warranted the prediction of early death. Brauell did not suspect that these bodies caused the disease, but, on the contrary, was of the opinion that they were transformed after death into the mobile vibrios of putrefaction.

In 1860 these little rods of charbon were studied by Delafond, who confirmed their significance in the diagnosis and prognosis of the disease when they were found in the blood of sick animals. He observed, further, that when the blood containing these bodies was preserved in small glass vessels in contact with the air they developed in the course of four days to two or three times their original length, while preserving about the same diameter. In eight or ten days their length was quadrupled or quintupled. These experiments having satisfactorily demonstrated that the anthrax filaments were an organic vegetable substance, he tried to obtain a complete development of this organism, that is, to make it produce spores or grains. In this he failed, but he concluded it was extremely probable that there circulated some time before death in the blood of animals affected with anthrax, multiplying prodigiously, vegetable filaments which might develop when the blood was drawn from the veins and placed in conditions favorable to vegetation, producing a very remarkable mycelium formed of numerous delicate filaments. He did not dare to decide whether the anthrax rods were the cause or the effect of the disease. Nocard and Leclainche remarked that the sarcasm with which these too advanced views were received is sufficient to explain his timid hesitation.

APPLICATION OF THE GERM THEORY TO ANTHRAX.

The publication in 1859 of Pasteur's memoir on butyric fermentation threw new light upon the development and effects of the micro-organisms, and led Davaine to apply the "germ theory" to anthrax, which he did in papers published during the years 1863 and 1864. This was a great step in advance, as previous to that time there was not only ignorance of the cause of anthrax, but of all contagious diseases. The nature of contagion was the bête noire of the medical profession. It was the one thing that appeared unattainable, either through the reagents of the chemist or the apparatus of the microscopist. There is consequently no need for wonder that when an investigator claimed to have pierced the impenetrable veil that for all time had shrouded this subject, he was met with the most pronounced skepticism and the keenest criticism.

For thirteen years the discussion continued without much progress either against or in favor of the new theory. New facts were produced, some of which apparently had a bearing in one direction and some in the other. Davaine's conclusion was still but a hypothesis or conjecture without positive evidence to sustain it. This was the condition of the subject when Koch published his remarkably able paper on the subject in 1876. He began by a study of the biology of the anthrax rods, finding that in the liquids of living animals they multiplied rapidly by lengthening and dividing, and that although he inoculated them from mouse to mouse for twenty consecutive times, no other forms were produced. In the blood and juices of dead animals or other favorable nutritive liquids, with admission of air and between certain extremes of temperature, they grew into extraordinarily long threads, with the formation of numerous spores. These spores, placed in a suitable liquid under favorable conditions, germinate and produce again the bacillus threads.

The bacillus threads or filaments are delicate and easily destroyed. A few days in an unfavorable temperature, a similar period deprived of air, diluting the fluid containing them with a large quantity of water, or drying the substances containing them was sufficient to destroy their vitality. On the other hand, the spores are very resistant, and when once formed are capable of existence under the most unfavorable conditions. These facts furnished the clew by which Koch was able to demonstrate the agency of this particular organism in causing the disease known as anthrax.

When fresh anthrax blood was preserved without contact with the air till the filaments died, the fluid at once lost the power of communicating the disease, as shown by inoculation experiments. On the other hand, with the admission of air under otherwise identical conditions, the organism grew, formed spores, and the liquid retained its virulence indefinitely. Again, by admitting air, but by keeping the fluid in a temperature of 8° R., which prevented the formation of spores before the rods died, the virulence was again lost. So by drying rapidly or by diluting with much water the death of the bacilli resulted and the activity of the liquid disappeared. Koch further showed that when spores had once formed, neither cold, nor deprivation of oxygen, nor drying, nor dilution with water any longer destroyed the virulence of the anthrax liquids.

Here was a scientific demonstration of the identity of this microorganism with the active principle of the infectious liquids. It showed that while the bacillus or its spores retained vitality the contagion existed, and when the bacillus lost its vitality without forming spores the contagion disappeared. The connection between the bacillus and the contagion was established beyond reasonable doubt.

The publication of these facts placed the germ theory of contagion upon a solid foundation which neither the storms of criticism nor the earthquakes of negative evidence have been able to destroy.

The first objection raised to this theory was that when the blood first becomes virulent no bacilli can be discovered by the most careful microscopical examinations; if the bacilli were the cause of the disease they should be apparent as soon as the blood is capable of communicating it by inoculation. Pasteur explained this fact as due to the difficulty of discovering one or two bacilli in such a large surface as is made by a drop of blood under the higher-power lenses. For instance, a drop of blood pressed flat between the object glass and thin cover presents a surface of one-half inch in diameter; this magnified only 500 diameters gives a surface with a diameter of 20 feet. And this is sufficient to fill the field of vision nearly 1,800 times. The accuracy of this explanation was proved with culture experiments, by showing that whenever the blood was virulent a drop of this blood added to a suitable culture liquid would produce an abundant growth of the bacillus.

The distinguished investigator, Paul Bert, took up the subject, and read a paper before the Académie des Sciences, in which he showed that compressed oxygen, which was supposed to kill all living things, did not destroy the anthrax virus, and that blood treated with it would still yield an alcoholic extract capable of producing anthrax. Now, absolute alcohol, as well as compressed oxygen, had been supposed to be fatal to all life. If, then, the virus survived both the action of compressed oxygen and solution in alcohol, he reasoned it was because it was not a living organism, but a chemical agent allied, perhaps, to diastase.

Once more the genius of Pasteur was equal to the occasion, and he demonstrated, to the satisfaction of Bert, that although the bacilli were destroyed by the agents he had used, their spores were not. He subjected Bert's alcoholic extract to microscopic examination and proved the presence of large numbers of these spores. Bert afterwards found that such spores preserved for five months in ordinary alcohol were as virulent as at first.

THE GERM THEORY ESTABLISHED.

The great contest over the germ theory of disease was settled by the experiments reported in 1876 and 1877, and the way was open to apply this great discovery to practical medicine. What a revolution in medical thought and practice has resulted can only be appreciated by comparing the text of medical works of twenty-five years ago with that of the present day. There were some individuals, however, who could not understand the difference between positive and negative evidence, and who did not for years fully grasp the fact that the germ theory was established. These persons continued to raise objections, and some of them are still telling us that investigators have gone mad over bacteriological studies and that the whole structure which they have raised during the last quarter of this century is doomed to crumble and disappear. Such objectors can have little effect upon the progress of science at this day, since every student has learned that a fact once established by positive evidence is as solid as the mountains and endures for all time; yet, many will die without accepting the germ theory, just as numerous contemporaries of Harvey died disbelieving in the circulation of the blood, but the recorded facts and the demonstrations of the germ theory will stand, as Harvey's discovery has stood, and it is as fruitless to inveigh against them as to attempt to sweep back the rising tide with a broom.

Many practical results in the treatment of anthrax outbreaks have followed the discovery that it is caused by a particular microscopic organism which we now know as the *Bacillus anthracis*. It has been recognized that this bacillus may multiply in the soil and in stagnant water; that its spores may retain their vitality and virulence after remaining in the earth for many years; that these spores form in the carcasses of dead animals and are brought to the surface from the pits where such carcasses are buried through the agency of earthworms; that disinfection, as it was practiced previous to 1876, was ineffectual in destroying the spores of this microbe, and that more active agents were required; that the essential condition which keeps up the disease is not the character of the soil, not the condition of the atmosphere, not the defects of the stable, but the presence of the bacillus in the soil of the pastures and upon the forage gathered from infected fields; and, finally, that the bacillus may be attenuated and form a vaccine which will in most cases grant immunity and protect animals from the infection. The use of this vaccine is increasing, and has reduced the mortality in the infected districts from an average of 10 per cent with sheep to less than 1 per cent, and from 5 per cent with cattle to less than one-half of 1 per cent.

BLACKLEG (SYMPTOMATIC ANTHRAX).

This disease, which is characterized by a rapidly developing swelling, with the abundant formation of gas in the tissues of the affected part, is seen principally in cattle, and until recent years was supposed to be identical in cause and nature with anthrax fever. The swelling appears most frequently in the upper part of the limbs, and when cut into is found filled with blood and very dark in color; hence, the name blackleg, by which it is commonly known in the United States. It is a common disease and almost invariably fatal.

DESCRIPTIONS OF BLACKLEG FROM OBSERVATIONS.

When Chabert wrote his classical description of anthrax in 1782, as we have already seen, he divided it into three clinical forms: (1) Anthrax fever, or internal anthrax; (2) essential anthrax, manifested by external swellings without preceding symptoms of fever; (3) symptomatic anthrax, beginning with fever and soon followed by external swellings. In the first division there could only be included cases of true anthrax, but in the second and third divisions there were brought together those forms of anthrax in which the virus penetrated the skin or mucous membrane and formed a visible swelling at the point of entrance, and also the swellings due to the contagion of an entirely distinct disease now known as blackleg, or symptomatic anthrax.

In general, the anthrax swellings precede the fever, while with blackleg the swellings frequently precede and often follow the fever. Chabert's classification, while a great advance from the ideas of his predecessors, was in this respect artificial and inaccurate, but was nevertheless the accepted interpretation of the facts for nearly a century.

There was little advance in the knowledge of this subject until 1856, when Walraff described an emphysematous form of anthrax, thus calling attention to the essential difference between the clinical symptoms of the anthrax and blackleg tumors, but he apparently did not suspect that they were distinct diseases. Bollinger in 1873 and Feser in 1875 pointed out marked differences, and Schindler and Weber in 1876 again called attention to the disease characterized by these emphysematous, or gaseous, tumors, and expressed their opinion that it should be differentiated from anthrax, since no case of its transmission to man had been observed, although the skins of affected animals were utilized, and the flesh even was consumed by the inhabitants of the infected districts in the Alps.

These opinions were not generally accepted, or at the best were regarded as of the nature of conjectures rather than demonstrations.

The divergent views expressed by different authorities and the apparent inconsistency of the observations served to increase the confusion rather than to bring order and light into the controversy. It had been observed that anthrax fever was often communicated to the men who handled the carcasses or skins of animals which had died of the disease, and that such accidents never occurred from the emphysematous tumors of symptomatic anthrax. In attempting to learn the reason for the transmission in one case and apparent noncontagiousness in the other, when both were regarded as essentially the same disease, inoculation experiments were made which showed that anthrax fever was regularly communicated from animal to animal by inoculation with the blood of an affected animal, while the blood of animals affected with symptomatic anthrax was not virulent, and material from the diseased tissues failed to communicate the disease in the great majority of cases. Did these facts indicate that two distinct and separate diseases existed where but one had previously been recognized? or, did they simply mean that in anthrax fever the disease was generalized and the contagion circulating throughout the body, while in symptomatic anthrax the contagion was localized in the swelling, which was the principal symptom of the morbid condition, and that it was here modified by septic complications?

THE NATURE OF ANTHRAX DEMONSTRATED BY EXPERIMENTS.

This question could not be answered by observation alone, nor were those who attacked it by experimentation able to solve the difficulties until the inspiration which followed from the investigations of Koch and Pasteur pointed the way. The demonstration that the *Bacillus anthracis* is the cause of anthrax fever, the clear description of its form and biological characters which enabled the investigator to identify it with certainty, and the methods of cultivating and studying bacteria introduced at this period made it possible for Arloing, Cornevin, and Thomas to carry out the brilliant series of experiments which demonstrated that anthrax fever and symptomatic anthrax were entirely different and distinct diseases.

These investigators published their first paper in 1879, three years after Koch had shown that anthrax fever was caused by the *Bacillus anthracis*, and when it was well known that the bacillus was easily found in the blood and tissues of animals which had died of that disease. They announced that careful microscopic examination and cultures, according to Pasteur's method, failed to reveal the *Bacillus anthracis* in the tumors or in the blood of animals affected with blackleg either before or after death. They also made thirty-four inoculations, using three young cattle, three sheep, two horses, and twenty-six rabbits and mice. All of these failed to communicate the disease. They therefore concluded that neither the blood nor the liquids of the tumors or affected lymphatic glands, in cases of symptomatic anthrax, contained either the *Bacillus anthracis* or its spores.

In later communications it was shown that blackleg is inoculable from animal to animal, and that the failures of the earlier inoculation experiments were partly due to the use of insusceptible animals. Cattle, sheep, goats, and guinea pigs readily contract the disease. Horses, swine, dogs, cats, rabbits, and fowls are either immune or have a great power of resistance toward this virus. Even cattle, the species in which this malady develops most frequently under natural conditions, are not susceptible at all ages. Calves under three months old and cattle over four years were found to have a high resisting power.

It was also necessary to determine experimentally the parts of the body in which the virus existed in most concentrated form. The blood is not virulent until just before death, and then, like the serum from the tissues surrounding the tumors, often fails to communicate the disease. The liquid of greatest virulence is obtained from the most discolored and darkest parts of the tumor, though the bile and amniotic liquid are both quite active. Further, it was found that a certain dose of virus must be used, and that this should be inserted into favorable portions of the body in order to obtain uniform results.

Microscopic study of the virulent liquids revealed the constant presence of a rod-shaped microorganism, which is endowed with power of active motion and having in many cases a spore at one end. The first attempts to cultivate this germ were not successful. It would not multiply in the presence of oxygen, as it belonged to that class of organisms known as anaerobic, and it required liquids of special composition to favor its growth. These difficulties overcome, it was found that the bacillus could be grown through many generations and retain its virulence indefinitely with proper conditions of environment.

BLACKLEG AND ANTHRAX COMPARED.

The bacillus of blackleg differs remarkably in some respects from that of anthrax. While the former is anaerobic and forms spores within the body of the living animal, the latter is aerobic and can only form spores after it has come in contact with the air. These peculiarities in the microbes explain the remarkable differences in the resisting powers of the two forms of virus under varying conditions. The spore being the resting stage of the bacillus and the form in which it is most resistant to unfavorable conditions, it is clear that, if this microorganism is the true cause of the virulence, the virus should retain its active properties longer and be more difficult of destruction when it contains spores than when rods alone exist. This is exactly what was found to be the case, and it explains why a disinfectant which will destroy the contagion at one time will not do so at another.

The contagion in fresh anthrax liquids, as they contain no spores, is destroyed in a few minutes by a temperature of 58° C., while fresh blackleg virus, always containing spores, requires a temperature of 100° C. for twenty minutes to produce the same effect. And on account of this ever-present spore the blackleg virus more surely resists the influence of putrefaction and other unfavorable conditions, and is therefore one of the most difficult to eradicate of all the known forms of contagion.

Comparing anthrax and blackleg experimentally, it was found that the former was easily communicated by scarifications or pricking the skin with a lancet charged with the virus, while the latter was only exceptionally transmitted in this manner. When inoculated into the connective tissue the local lesion produced by anthrax virus in most cases consisted of a small inflammatory area, with slight accompanying œdema, while blackleg virus similarly inoculated caused an enormous swelling, with abundant œdema. Again, the inoculation with anthrax virus into the veins is more dangerous than when inserted into the connective tissue, and is fatal with infinitesimal doses. On the contrary, blackleg virus may be inoculated into the veins in much larger doses than into the connective tissue without producing fatal effects. It was shown that one attack of either of these diseases granted immunity from that particular contagion, but that an attack of anthrax did not protect from blackleg nor did an attack of blackleg protect from anthrax.

REMEDY FOR BLACKLEG.

The above experimental studies consequently established the fact beyond controversy that two distinct diseases had previously been grouped together; that the germs of these two diseases were distinct and very different in their biological characters, and that different measures were required for their control.

These investigators did not stop at this point, however, but continued their researches with a view of finding a prophylactic treatment. The remarkable success of Pasteur in attenuating the virus of anthrax and fowl cholera led them to endeavor to produce an attenuated virus, or vaccine, for blackleg. This was finally accomplished by drying the virulent flesh and afterwards reducing it to a powder and subjecting it to a temperature between 85° and 100° C. for a sufficient time to properly reduce its activity. This vaccine, perfected by years of experience, is now in use in most parts of the world. It is supplied by the Bureau of Animal Industry to the stock raisers of the United States to the extent of half a million doses a year, and where used has reduced the losses on infected pastures from 10, 15, or 20 per cent, which annually occurred before using, to less than 1 per cent per annum.

This great practical triumph in the control of an infectious disease is due entirely to the application of the experimental method. Without experiments upon living animals and confined to clinical observation, it was impossible to determine whether anthrax and blackleg were essentially identical in nature or whether they were distinct diseases, and much less was it possible to isolate and identify the germ or so to change the activity of this organism as to transform it from one of the most deadly organisms to a harmless protective vaccine.

TEXAS FEVER, SPLENETIC FEVER, OR SOUTHERN CATTLE FEVER.

HISTORY OF TEXAS FEVER.

In 1814 we find the first known accounts of a disease being disseminated by apparently healthy cattle from certain districts in the Southern States when these cattle were driven North to market. Attention was at that time called to this phenomenon by Dr. James Mease in a lecture before the Philadelphia Society for Promoting Agriculture, who stated that the cattle from a certain district in South

Carolina so certainly diseased all others with which they mixed in their progress to the North that they were prohibited by the people of Virginia from passing through the State; that these cattle affected others while they themselves were in perfect health, and that cattle from Europe or the interior taken to the vicinity of the sea were attacked by a disease that generally proved fatal. In a paper read before the same society in 1825 he says: "The circumstance of cattle from a certain district in South Carolina affecting others with this disease has long been known."

The precise locality from which these cattle originated, or its extent, he was, however, unable to ascertain, notwithstanding inquiries upon the subject.

Dr. Mease gave an account of an outbreak of this disease which occurred in 1796 in Lancaster County, Pa., as a result of South Carolina cattle being brought and sold there. These cattle were penned over night in a plowed field and did not come in contact with the cattle on the farm; nevertheless, the latter commenced dying a short time afterwards. In every instance where sold they communicated the disease to the cattle with which they mixed. The symptoms were loss of appetite and weakness of the limbs, amounting to inability to stand; when they fell, they would tremble and groan violently. Some discharged bloody urine, others bled at the nose. On being opened the kidneys were found inflamed and sometimes in a state of suppuration.

Many similar outbreaks occurred in North Carolina, Virginia, and Maryland in the first half of the century, but the accounts of them are too meager to be of use. Legislation was enacted in North Carolina, however, as early as 1837 to prevent the driving of cattle into that State from either South Carolina or Georgia between the first day of April and the first day of November; also, to prevent cattle from being driven from those parts of North Carolina, where the soil is sandy and the natural production or growth of timber is the long-leafed pine, into or through any of the highland parts of the State, where the soil or growth of timber is of a different kind, between the dates already mentioned.

Very little more was heard of this disease until about 1850, when cattle bred in Texas began to be driven through Arkansas, Missouri, and Kansas for distribution to feeders in those and other Western States. A mysterious and highly fatal disease then appeared along the great roads, highways, or trails over which these cattle were driven, destroying about 50 per cent of all the native cattle. Persons living near the fording places lost as high as 90 per cent. It was two years before the origin of this disease was traced to the Southern cattle.

From 1856 to 1860 many Texas cattle were driven into the States of Kansas, Missouri, Kentucky, Iowa, and Illinois, and it was stated that the native stock in the sections to which they were taken were swept away by a "dry murrain." An epizootic under such circumstances was so unexpected and contrary to all previous experience that at first the source of the disease was not suspected, and when the Southern cattle were accused there were many who looked upon their presence as a mere coincidence. However, by 1861 the conviction that Texas cattle disseminated disease became so strong that laws were enacted by the States of Kansas, Missouri, Kentucky, and Illinois regulating the movements of Southern cattle.

The disease ceased in these States during the civil war and its ravages had apparently been forgotten, when it reappeared during 1866, 1867, and 1868 with the first droves of cattle from Texas. There was little attention given to it at first, as the number of cattle driven in 1866 and 1867 appears not to have been very large. In 1868, however, the markets and other conditions were more encouraging to those who handled this class of stock, and large herds of Texas cattle were sold for feeding in Illinois, Indiana, Ohio, Pennsylvania, New York, and other Northern States.

As the hot weather of summer came on the disease broke out wherever the Southern cattle had been taken. Of 320 head of native stock shipped from one farm to the East for slaughter, 224 died before they reached their destination, and the remainder were said to have been sent to the rendering tanks. At the little town of Tolono, Ill., from 15,000 to 18,000 Texan cattle were landed. The fever commenced its destructive work about July 20, sweeping away nearly every native animal of the bovine race in that section. Nine hundred and twenty-six head of cattle died in that township, which polled but a trifle over 200 votes, and 5,000 head succumbed in the county. Within 2 miles of the Chicago stock yards, according to the report of the medical officer of the city, but 1 cow escaped, 161 animals having perished. In the vicinity of Loda, Ill., it was estimated that not less than 1,800 cattle died. In Warren County, Ind., the losses reached about 1,500 head; in Jasper County, 400 head; in Marion County, 100 head.

These losses are simply examples of what was occurring in many parts of the Northern States. The disease was soon traced to the Southern cattle, and in the absence of specific knowledge concerning its character there was great alarm as to the extent to which it might spread and its effect upon the public health. While the direct loss from the disease was very heavy and brought disaster to many individuals, the contagion was fortunately one which did not spread from the sick native cattle, and was consequently self-limited. It was also a disease that is not communicable to the human species, and hence did not appreciably affect the public health.

INVESTIGATIONS OF TEXAS FEVER BY THE DEPARTMENT OF AGRICULTURE AND BOARDS OF HEALTH.

The excitement and interest aroused by the outbreak of 1868 led to extensive investigations by the Department of Agriculture and by the boards of health of Chicago and New York. These researches were sufficient to establish the symptoms, the post-mortem lesions, and some of the peculiarities in regard to the transmission of the disease. It was shown that there was intense fever, with a temperature ranging from 105° to 110° F., accompanied by great weakness and prostration. The ears and head drooped, the hind legs were advanced under the body, and the fetlocks were partially flexed, constituting, when taken together, a more or less characteristic attitude. The urine, at first tinged with red, became deeper colored, until it had the appearance of undiluted venous blood. On post-mortem examination the liver and spleen were found to be the organs most seriously affected. Both were congested and enlarged. In the liver there was bile-stasis in the ultimate biliary canaliculi, which were found distended and occluded, while the spleen was greatly engorged with blood, and its interior was transformed into a dark semifluid mass. The kidneys, also congested, presented numerous blood extravasations in the pelvic portion.

A study of these symptoms and lesions threw little light upon the nature of the disease. The condition of the spleen suggested that it might be allied to anthrax, but there was an absence of the gelatinous exudations seen in that disease, and, moreover, there was no case of the transmission of the malady to mankind. The course of the disease was also longer than in anthrax fever. A consideration of the phenomena observed relating to the transmission of the contagion only served to deepen the mystery. The cattle from the South which brought the disease were themselves apparently healthy. The sick Northern cattle did not communicate the disease. The contagion in most cases was confined by ordinary farm fences, and, indeed, it appeared to be the ground over which the Southern cattle had traveled rather than the cattle themselves which was dangerous to susceptible animals. And this infected ground retained its power to communicate disease until it was purged by the frosts of approaching winter.

Strange to say, the pastures did not always become dangerous immediately after the Texas cattle had traveled over them. In some cases it was observed that susceptible cattle had fed upon such pastures for a month or more after the Texas cattle had left them, and had then been removed to other fields without sustaining any injury, while other Northern animals of the same lot allowed to remain a few weeks longer suddenly developed the disease in a most violent form. How different from the phenomena of other contagious diseases were these manifestations! and how inexplicable in the light of the medical knowledge of that day! Of what did this contagion consist that it could be propagated by well animals and not by those affected with the disease; that it could remain upon pastures inactive and resist sun and rains for weeks and then suddenly attack in the most virulent form all Northern animals that so much as walked across them, while it respected the animals from the South? Surely they were justified who called this a "romance in pathology," since these phenomena were without precedent and to the most enlightened appeared incredible.

These investigations of 1868 and 1869 established the more apparent characteristics of the disease, though for sixteen years afterwards there were scientific men who tried to prove that no such disease existed. During all this time the cattle driven from Texas and Indian Territory to the Northwestern States and Territories for grazing left a deadly trail behind them, which was destructive to the native cattle that crossed it. The stock yards and stock cars became more and more infected, and cattle purchased in the public markets and taken back to the farms for feeding were in so many instances found to have contracted the disease that purchasers avoided such places as much as possible. Even our export cattle that were given the greatest care en route became infected, and as many as two or three hundred would sicken on a single ship. This brought American cattle into disrepute and threatened to lead to annoying restrictions or even prohibition by foreign governments.

TEXAS-FEVER DISTRICT DEFINED AND EFFORTS TO SEPARATE INFECTIOUS CATTLE.

The almost intolerable condition described above existed when the writer took up the study of Texas fever in 1879.

The first questions were: How shall this difficult problem be attacked? and, what methods of investigation shall be adopted? One question that appeared possible of solution had reference to the extent and the exact boundaries of the district from which the cattle came that spread the contagion. This could be determined partly by collecting all the information possible as to outbreaks of Texas fever in the Northern States and ascertaining exactly where the cattle came from which caused them, and partly by ascertaining the sections of the Southern States where Northern cattle imported to improve the stock were liable to die with acclimation fever, a disease which the writer had shown to be synonymous with Texas fever.

By pursuing these lines of investigation a great section of the country was found to be already invaded by the infection. This section included half of Virginia, the greater part of North Carolina, all of South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas, and large portions of Tennessee, Indian Territory, and Texas. The defining of this district made it possible to separate the infectious cattle in the cars and pens, while in transit, from the Northern susceptible cattle, and thus tended to lessen the spread of the contagion. However, there were many difficulties in enforcing regulations for this purpose, as there was no way of distinguishing between these different classes of animals when they reached their destination, and the waybills and car marks could not be implicitly relied upon. It was also desirable to know of what the contagion consisted, how it was disseminated, what disinfectants could be used to destroy it and in what strength these should be present to be active, what was the true period of incubation, what measures could be adopted to reduce the losses among pure-bred cattle taken to the Southern States to improve the stock, and what safeguards could be thrown around cattle from the infected district when taken North for grazing so that they would not destroy the animals in the sections to which they were permitted access.

The people of the South said: "What right have you to put restrictions upon our cattle when they are going to market? There is no disease among our cattle; and if the Northern cattle sicken and die, the loss should not be charged against our healthy cattle, the presence of which in certain cases was probably a mere coincidence." These arguments were difficult to meet, doubly so when the cases went to the courts, and it became necessary to explain the part played by the Southern cattle in originating the disease. Here, as in many other cases, observation of the outbreaks which developed spontaneously failed to reveal the mysteries, and it was necessary to question and cross-question nature through experiments in order to obtain the information which she withheld from the ordinary observer.

CONJECTURES AS TO MANNER OF DISSEMINATION OF TEXAS FEVER.

There were numerous conjectures as to the manner in which the contagion was disseminated. Some thought that in driving the Southern cattle such long distances their feet became worn, sore, and ulcerated, and that the discharge from these ulcerated surfaces poisoned the grass and developed contagion. It was believed that this hypothesis was confirmed by the known fact that the Southern cattle apparently lost the power to transmit the disease after they had been upon the Northern ranges sixty to ninety days. Another conjecture was that the contagion resided in the saliva and was distributed over the grass while the infectious animals were grazing. It was also contended by some that the Texas cattle became infectious by drinking from pools of stagnant water, particularly that which contained alkali, and that the infection was distributed with the urine and excrement. Still another conjecture was that the ticks, with which most of the Southern cattle were covered, passed from these to the Northern animals, and the latter, not being accustomed to their bites, became affected with and died from the irritation and fever thus induced. A modified form of this hypothesis was also held, to the effect that the ticks dropped from the Southern cattle laid their eggs in the grass; that myriads of young ticks hatched, covered the herbage, and were taken into the stomachs of the cattle with the food, causing inflammation of the digestive organs, fever, and death.

How were we to decide which, if any, among these divergent views was the correct one? The writer was asked to make a hasty examination of the subject and prepare a preliminary report for publication. This he did, and it is at least instructive as to methods to read his views concerning the part played by the ticks in the transmission of the contagion. The following appeared to be extremely good arguments at the time the report was written (1880):

The tick theory.—One of the most widely spread opinions in regard to the causation of Southern fever is the pathogenic influence of the ticks with which Southern cattle are generally covered and which migrate in large numbers to the bodies of other cattle with which they mix. But the acceptance of this view is simply an evidence of the desire of the human mind to explain the origin of mysterious phenomena. The same principle is exhibited in the popular views regarding the pathogenic nature of *hollow horn*, *hollow tail*, *wolf teeth*, *black teeth*, *hooks*, *etc.*, none of which have the least foundation in fact or reason. The tick theory scarcely explains a single one of the many peculiar phenomena of the disease. Ticks are found everywhere, but are simply more numerous at the South. Their attacks are not confined to the latter half of the summer, nor would they be likely to remain on a pasture from spring till August without doing harm and then suddenly cause an outbreak of the disease. Again, the post-mortem examination plainly indicates the cause of the disease to be an agent taken into the circulation and causing the most important changes in the composition of the blood.

Alas, for the limitations of human observation and reasoning when we fail to establish our premises by rigid experimentation! It has since been shown by experiments, outlined by the writer and carried out successfully by his direction, that the ticks do transmit the contagion of Texas fever, and that all of the mysteries connected with this transmission are explained by an accurate knowledge of the biology of the particular tick involved (*Boophilus bovis*), and of the other parasite (*Pyrosoma bigeminum*), which cooperates to produce the pathogenic effect.

EXPERIMENTS TO DETERMINE THE CAUSE AND DISSEMINATION OF TEXAS FEVER.

The first step toward revealing the nature of the disease was evidently to determine if it could be inoculated from animal to animal. If this question were decided in the affirmative, it would be possible, by continuing the inoculation experiments, to determine how widely the virus was distributed through the body, and with what secretions or excretions it was disseminated by the affected animal. It might also be possible to identify a microorganism as the essential cause and to study its biology.

With these purposes in view, the writer, in 1879 and 1880, inoculated six head of cattle and drenched three with liquids that appeared most likely to contain the contagion. Two of these animals had an attack of fever, one being so seriously affected that it became quite weak and emaciated. In 1882 three more animals were inoculated, one of which became sick in ten days and died three days later of acute Texas fever. This was the first demonstration of the inoculability of the disease, and it proved that a mixture of blood and splenic pulp contained the contagion.

In 1886 Dr. Smith, in studying microscopic preparations from the spleen of an animal that had died of the disease, observed peculiar bodies in the red corpuscles which were suggestive of parasitic micro-organisms. In 1888 and 1889 further studies of these bodies were made, which led to the conclusion that they were protozoa. As the most prominent feature of the disease was found to be a breaking down and destruction of the red corpuscles, and as these parasites existed almost exclusively in the red corpuscles of the blood, there was some reason to think they might be the cause of the disease.

At this period, having completed the survey of the permanently infected district, the writer observed that this district corresponded almost exactly with the habitat of the tick (*Boophilus bovis*), which was almost invariably found to infest the cattle that were capable of transmitting the disease. Taking this coincidence, with the strong belief held by many cattle men of experience, that the ticks had something to do with the production of the disease, it was determined to have this aspect of the question fully investigated. Dr. F. L. Kilborne, who was at that time in charge of the Bureau experiment station, was consulted and given explicit instructions to carry through one or more series of experiments with this object in view. The first experiments were made in 1889, and the result was: (1) That Northern cattle pastured in a field with cattle from the infected district which were infested with ticks contracted Texas fever; (2) that Northern cattle pastured in a field with cattle from the infected district that were carefully freed from all ticks by hand picking did not contract Texas fever; (3) that Northern cattle pastured in a field where no cattle from the infected district had been, but over which had been scattered a large number of ticks, contracted Texas fever.

The result of these experiments was a distinct and positive advance in our knowledge of the disease. It was now known (1) that the disease was inoculable; (2) that the blood of diseased animals contained a microscopic protozoan parasite; (3) that ticks picked from Southern cattle and spread upon pastures were a means of communicating the infection.

It was next important to learn in what manner the ticks conveyed the contagion. From a medical point of view the most plausible theory was that the biting parts of the ticks became soiled with the blood of the Southern cattle, and that these contaminated ticks, migrating to susceptible cattle, carried the virus and inserted it when they began sucking blood from the latter. A study of the life history of the tick showed, however, that this theory was not consistent with the facts. The ticks do not leave one animal and go to another. When they are once upon an animal they remain there until they become mature, and then they drop off, lay their eggs on the surface of the ground, and die. There is no opportunity for this parasite to carry blood directly from the Southern to the Northern animal and inoculate it.

Another hypothesis was that with the blood sucked from Southern cattle the tick took into its body the virus of the disease, and that when the mother tick died and became disintegrated upon the pastures the contagion was liberated and the grounds infected. This supposition was entirely demolished by experiments, which proved that the disease was caused by young ticks hatched from the eggs of the mature ticks which developed upon the Southern cattle, that is, the contagion is in some manner transmitted from the adult tick through its egg to its progeny, and this progeny has the power of inserting the contagion into the circulation of the cattle upon which it happens to fasten itself.

These facts threw much light upon the propagation of the malady, but they were not sufficient to establish a scientific theory explaining the transmission. Indeed, it was yet to be proved that the Southern cattle carried the protozoa in their blood. Microscopic examination was not sufficient to decide the question. A few minute points were observed in the red corpuscles of Southern cattle, but these points were much smaller and far less numerous than the protozoa in sick Northern cattle. The Southern cattle, besides, were in good health, and it seemed improbable that they harbored so deadly a parasite.

There was but one way to decide as to whether Southern cattle carried this contagion in their blood, and that was to inoculate susceptible Northern cattle with the blood of Southern cattle. This experiment was made, and it demonstrated that a comparatively small quantity of blood from a Southern cow, injected under the skin or into the veins of Northern cattle, produced an acute attack of Texas fever. In Northern cattle infected in this manner the protozoa appeared in the blood corpuscles with the same characteristics as when the infection occurred through the medium of ticks. There could no longer be any doubt that the blood of cattle from the infected district contained the contagion of Texas fever.

It was now important to decide how long Southern cattle carried this contagion in their blood after leaving the infected district. Again, it was necessary to resort to inoculation, as the microscope was powerless to decide. The first experiments had been made with the blood of cattle immediately after they had been brought from the South. In the next experiment blood was used from an animal that had been away from the infected district seventy-four days. This also produced disease. In succeeding years experiments were made by inoculating with the blood of cattle that had been under observation, with no chance for reinfection, for one year, two years, three years, four years, five years, six years, and seven years, and in every case the disease was produced. It was concluded, therefore, that this contagion once introduced into the blood of cattle remained there in an active condition throughout the animal's life.

THE PRINCIPAL FEATURES OF TEXAS FEVER.

We were now in a position to understand and explain the principal features of this disease, that is, it was plain that cattle in the infected district carried in their blood the contagion of Texas fever; that this contagion was in reality a protozoan organism called the *Pyrosoma bigeminum*, analogous to the parasite of human malaria; that this parasite was transferred to susceptible cattle outside of the infected district by the Southern cattle tick *Boophilus bovis;* that Southern cattle, although carrying the contagion, were harmless unless infested by this particular tick; that the Southern cattle carried this contagion in their blood for years after leaving the infected district, and would again be dangerous to other cattle if by any chance they were reinfested with the proper species of ticks. A study of the biology of the tick showed that the time required for the eggs to hatch depends upon the atmospheric temperature, and that all the mysteries of the propagation and incubation of the disease depended upon the hatching of these eggs.

THE PROGRESS MADE IN THE CONTROL OF TEXAS FEVER.

The above is a remarkable chapter in the progress of medical science, and has already led to extensive studies of the part played by insects in the propagation of human diseases, and particularly the malarial fevers. That it has opened up a new field of medical research is unquestionable. What has it accomplished toward the control and eradication of Texas fever? In the first place, it has given us a ready method of identifying infectious cattle found in the channels of commerce. Previous to these investigations it was often impossible to tell whether a given carload of cattle unloaded at any stock yards was from the infected or noninfected district. The point from which it was billed was no criterion, since it was common to rebill cars, often for the express purpose of deceiving the inspectors. These great centers of cattle traffic were, consequently, continually infected. To-day, if cattle are infested with the *Boophilus bovis* ticks, they are sent without question to the quarantine yards.

Another line in which progress has been made is in lessening the area of the infected district. Whole counties have been placed above the cattle quarantine line, because the ticks have been destroyed in those counties and the danger of contagion removed. In many other counties the citizens have taken up the task of tick killing and are making rapid progress in freeing their districts from this pest. The infected district, instead of advancing and enlarging in area, as before these investigations, is now diminishing. This work is of immense advantage to the people of the districts involved.

Great success has also been achieved in immunizing cattle taken to the infected district for improving the stock. In the past the greater part of the cattle taken to the infected district died of Texas fever. These losses were 80, 90, and even 95 per cent of the animals introduced. Still, it was so important to grade up the cattle in the vast herds of the South and Southwest that the people of those sections persisted and accomplished much even under such discouraging circumstances. In pursuing the inoculation experiments it was learned that young animals, particularly calves, were much less severely affected than old ones, even with the same dose of virulent blood; also, that as cold weather approached a milder form of disease was produced in the same class of animals. Putting these two facts together, it was decided to immunize some young cattle and test their resistance in the infected district. This was successfully accomplished, and proved that young stock inoculated in the late fall or early winter with virulent blood contracted a mild form of disease, from which the experimental animals recovered, and that these animals sent to the infected district the following spring were but slightly affected with the disease, although untreated animals sent with them either died or were very severely affected and barely survived.

This method of immunizing has now been adopted in practice and is proving very satisfactory. Instead of a loss of 90 per cent among breeding stock taken South, it has been shown that more than 90 per cent can be saved. This means rapid improvement of Southern herds and a vast increase in the value of the animals produced.

There is one other problem under experimentation, which, if it can be solved, will remove the last terrors of Texas fever. That problem is the rapid and inexpensive destruction of the ticks upon cattle from the infected district. Such cattle are now dangerous because of these ticks. They are not allowed to go North, except for slaughter, during ten months of the year. They are always regarded with suspicion, quarantined, and sold as quarantine cattle at a reduced price. This is a constant hardship to the people of a great section of the country; but destroy all the ticks and the cattle are harmless and can go anywhere, for any purpose, at any season of the year. The plan of destroying the ticks is to drive the cattle through a vat containing some liquid that will be fatal to the ticks without injuring the cattle. While it has proved a difficult task to find a liquid that will answer these conditions, there are some which are so nearly satisfactory as to inspire hopes that success in this line will in the near future be achieved.

Confining our argument to the facts which have already been demonstrated, Have we not abundant justification for the experimental method? With a disease so obscure and complex, depending upon two different parasites for its dissemination, one of these so small as to tax the highest powers of the microscope, it was impossible for observation, unaided by experimentation, to solve the mysteries and elucidate it. But the experimental method was invoked, and, as in many other fields of biology, has brought order out of chaos, giving an intelligent comprehension and control of phenomena, where before were only ignorance and helplessness.

PROGRESS IN ECONOMIC ENTOMOLOGY IN THE UNITED STATES.

By L. O. Howard, Ph. D.
Entomologist.

INTRODUCTION.

At the beginning of the present century the United States, with its population of only 5,000,000, with its restricted geographical area, with its small fields and its comparatively slight diversity of crops, and with its infrequent communication and limited commercial relations with other countries, suffered comparatively little from the attacks of insects on its crops. There are old last-century records of the local destruction of the grain crops by the army worm, and as early as 1793 the cotton caterpillar did a great deal of damage to the cotton crop of Georgia and South Carolina. Similar outbreaks occurred in 1800 and 1804, while the Hessian fly,[1] as its name suggests, made its destructive appearance soon after the close of the war of the Revolution.

With the rapid growth of the new Republic, both in geographic area and in population, and with its marvelous agricultural development, many native plant-eating insects, finding in cultivated crops an almost unlimited abundance of food greatly to their taste, multiplied rapidly and became important factors in crop production. As commercial relations with Europe and other countries increased and as the introduction of steam made international journeys more and more rapid, new injurious insects were introduced from abroad, many of them becoming readily established and assuming an importance as crop enemies surpassing that of native species. Many of them, in fact, as has frequently been pointed out, became, for reasons which need not be discussed here and which are not well understood, more prolific and injurious than in their native homes. For a long time these imported species, beginning their work on the Atlantic seaboard, traveled westward by natural spread, entering new regions after a few years, following in the track of the pioneers. Comparatively few have entered our territory from the South, but with the development of agriculture

[1] The "Hessian fly" is a name which well illustrates a tendency to apply as a popular term to an injurious insect the cognomen of a disliked or hated class or individual. Other examples are the use of the name "Abe Lincoln bug" in Georgia after the close of the civil war for the harlequin cabbage bug, which at that time had just reached that State on its northeastward march; the later application of the term "Third Party bug" to the same insect in Texas, and the term "French weed" to the stink weed in portions of Canada of anti-Gallic sympathies.

upon the Pacific coast and with increasing commercial relations with countries beyond the Pacific, injurious insects have at last begun to reach us from a westward direction. From this it will be seen that as the century has grown older the need of remedies against insects has grown greater. Fortunately in this case, the supply of remedies has commensurately satisfied the demand, and the nation has not failed in this direction to justify its claim to be called "a practical people."

SOME OF THE WORKERS AND CAUSES OF PROGRESS.

FIRST NATIVE SCIENTIFIC ENTOMOLOGIST.

William Dandridge Peck, who commenced to write in 1795, was our first native scientific entomologist, and he was as well our first economic worker in this line. The first economic publication of value was probably his "Description and history of the cankerworm," originally printed in the Massachusetts Magazine for 1795, and reproduced in the Massachusetts Agricultural Repository and Journal under the title "The natural history of the cankerworm," in October, 1796. This first paper was followed by "Natural history of the slugworm" (the common cherry slug), published in 1799; "An important communication relative to the cankerworm," 1816; "On the insects which destroy the young branches of the pear tree and the leading shoot of the Weymouth pine," 1817; "Some notice of the insect which destroys the locust tree," 1818; and "Insects which affect the oaks and cherries," 1819, all of these articles being published in the Massachusetts Agricultural Repository and Journal.

FIRST OFFICIAL ENTOMOLOGIST AND HIS WORK IN MASSACHUSETTS.

Dr. Thaddeus William Harris (1795–1856) was probably the first American entomologist to receive public compensation for his labors, and in this sense he may be called the earliest official entomologist in this country. His first entomological article, entitled "Upon the natural history of the salt-marsh caterpillar," was published in 1823[1] and illustrated by an excellent full-page steel-engraved plate. Although it does not appear from the title, the article was of a distinctly economic character. The introductory paragraph reads as follows: "In the present state of agriculture, hay has become an important product to the farmer in this vicinity. From the high price and the increased demand for the imported and cultivated grasses, the indigenous and natural growth of the soil must rise in value; and of this perhaps none is more valuable on the seaboard than that of the salt meadows."

Dr. Harris shows that the ravages of insects in the salt meadows, particularly of caterpillars and grasshoppers, had become formidable, and states that the object of his paper is an attempt to elucidate the natural history of the caterpillars, "with the hope that it may lead to

[1] Massachusetts Agricultural Repository and Journal for 1823, pp. 322–331.

some sure method of exterminating them, or of limiting their ravages to a shorter period." After a full account of the life history of the species and of the dates of transformation, bringing out the interesting point that the caterpillars are imbued with so great a vitality that long immersion in water does not destroy their life, he concludes by recommending, first, that the grass should be cut early in July, and, second, that the marshes should be burned over in March. It was, in fact, a good, plain, practical paper.

The publication of Dr. Harris's first paper was followed by a constant succession of interesting and valuable articles, published for the most part in the New England Farmer, more than half of them being devoted to the economic bearings of entomology. In 1831 he prepared a catalogue of insects, which was appended to Hitchcock's Massachusetts Geological Report, and at a later period he was appointed by Massachusetts as one of a commission to make a more thorough geological and botanical survey of the State. In this capacity he prepared his noted classic report on insects injurious to vegetation, first published in full in 1841, the portion on beetles having appeared in 1838. He reprinted the work under the name of "treatise" instead of "report" in 1842, and again in revised form in 1852. The whole sum received by him from the State for this labor was \$175. After his death the work was reprinted by the State in its present beautiful form, with wood engravings which marked an epoch in that art. The practical value of Dr. Harris's work has been vast. His scientific reputation has steadily grown. His book is to-day as valuable as it was when first written, more than fifty years ago. On entering any entomological workshop in the land the first book that will catch the eye upon the desk is a well-worn copy of the "Treatise upon insects injurious to vegetation." He was fortunate in having a new field; but it is impossible to conceive that this field could at that time have been more intelligently worked, from both the scientific and the practical standpoint. Many new insect pests have been studied since his time, and many new and practical ideas in regard to the warfare against injurious insects have been advanced; but no one has had to do over the work which Harris did so well. He kept constantly in mind the idea that it is necessary to know the life history of the insect before suggesting remedies, and although in his work he had little to say about insecticides or their application, he was successful in many instances, as in the case of the salt-marsh caterpillar, to which reference has been made, in showing that after the life history and periods of transformation of a given insect foe are accurately known, some slight variation in cropping or in agricultural methods will do away with the loss. This important idea was lost sight of until comparatively recent years, and even of late the great developments in the mechanical destruction of insects caused it to become temporarily obscured; but there can be no doubt that as a general principle it affords the most natural method of fighting many insect pests. If Harris had been an agriculturist himself, or if he had known more of agricultural methods, he would perhaps have given his work a greater practical turn than he did. He was, as a matter of fact, a naturalist and a student in disposition; the fact that he was educated as a physician and was by occupation a librarian (theoretically an unfortunate combination for practical agricultural ideas) emphasizes the broad-mindedness of the man when we realize the value of his work.

INVESTIGATIONS BY THE STATE OF NEW YORK.

In his economic line Harris worked practically alone throughout the greater part of his career, until during the latter part of his life, when Dr. Asa Fitch, of New York (1809–1879), began to write for different agricultural journals about injurious insects. Two years before the death of Harris, in 1854, the New York State legislature made an appropriation of $1,000 for an investigation of insects, especially of those injurious to vegetation, and authorized the appointment of a suitable person to perform the work, the matter being placed in the hands of the New York State Agricultural Society. Dr. Fitch received the appointment, and from 1854 to 1870, with the exception of the years 1859, 1865, and 1868, he published an annual report in the "Transactions of the New York State Agricultural Society." The value of his labors was great. In his fourteen reports the great majority of the injurious insects of the State of New York received more or less detailed consideration, and in most cases the life histories of the insects treated were worked out with great care. The remedial measures which he suggested have, however, been largely improved upon, and the practical value of the reports to-day rests almost entirely on the life-history side.

COMMENCEMENT OF INVESTIGATIONS BY THE GENERAL GOVERNMENT.

At about the time when the State of New York began her annual appropriation to support State work in economic entomology, the General Government, in a small way, took up the same line of investigation. Townend Glover was appointed on June 14, 1854, by the Commissioner of Patents to collect statistics and other information on seeds, fruits, and insects in the United States under the Division of Agriculture of the Patent Office. His first report, illustrated by six plates engraved on stone by the author, was published in the Annual Report of the Commissioner of Patents for 1854, and comprised some consideration of the insects injurious to wheat, the cotton plant, and the grapevine; also of the plum curculio, codling moth, and peach borer, closing with an account of the more common species of beneficial insects. His second report, in 1855, continued the consideration of cotton insects and contained some account of insects affecting the orange. He published nothing in 1856 and 1857, but in 1858 he continued his report upon orange insects. He then resigned his position, to be reappointed in 1863, shortly after the establishment of the Department of Agriculture as a separate institution. From that date his reports follow consecutively down to 1877. From 1856 to 1866 Fitch and Glover had the field in economic entomology in the United States practically to themselves.

OCCASIONAL ENTOMOLOGICAL WRITERS.

Occasional entomological articles were published in agricultural and other journals, among the writers of which may be mentioned Miss Margaretta H. Morris, Dr. William Le Baron, James Kirkpatrick, Dr. S. S. Rathvon, Dr. S. S. Haldeman, Cyrus Thomas, Thomas Affleck (in the South), and, beginning in 1864, Dr. Isaac P. Trimble.

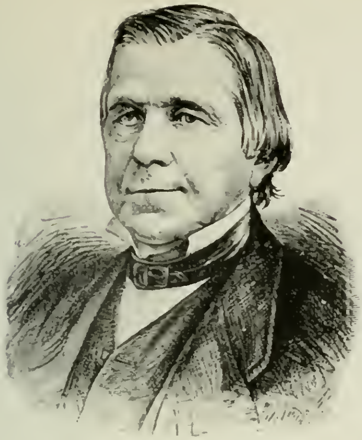
INVESTIGATIONS BY THE STATE OF ILLINOIS.

In the above list we have not mentioned perhaps the most forcible and clearest of all, a man who combined in the highest degree practical ideas with scientific attainments, for the reason that he deserves separate and independent mention. This was Benjamin D. Walsh (1808–1869). He began to write on economic matters in 1860, and continued to do so with great prolificacy until the time of his death, publishing in all three hundred and eighty-five articles upon injurious insects. In 1865 he founded the first journal devoted to economic entomology in this country, and the writer is inclined to believe the first in the world. It was entitled "The Practical Entomologist," and was published by the entomological society of Philadelphia, lasting through two volumes of twelve numbers each, being discontinued in September, 1867, for lack of financial support. In the meantime, however, the Illinois State legislature during the winter of 1866–67 passed a law, as the result of a petition from the State horticultural society, enacting that a State entomologist be appointed by the governor with a salary of $2,000 per annum for a period of two years. At a special session of the legislature held in June, 1867, the governor sent in the name of Mr. Walsh for confirmation, but the senate postponed action upon it until the next regular biennial session in the winter of 1868–69; hence, it follows that Mr. Walsh's first and only official report was published as acting State entomologist, its preparation having been delayed by a long period of ill health which preceded the railway accident that was the immediate cause of his death.

Walsh was a very forcible character, a ready writer, and a ready public speaker, and by virtue of his strong personality, as well as by a marked hatred for fraud and pretense, was the best man who could have been found to place the comparatively new field of investigation upon a firm basis. He showed up prevalent quack remedies in the most scathing and at the same time humorous manner, and attracted new workers to his school. An instance in his career, illustrating his power as a speaker, reminds one of the circumstances surrounding the so-called "lost speech" of Abraham Lincoln. Walsh delivered a lecture before the Illinois State Horticultural Society in January, 1860. He spoke extemporaneously for two hours, communicating his ideas in such a manner as to hold the audience perfectly. The reporter of the lecture stated that he became so intensely interested that his hand refused to move his pencil. In 1868, in joint editorship with Charles V. Riley, Walsh started a second journal devoted largely to economic entomology, which was known as the "American Entomologist," and which also lasted through two volumes before lack of funds caused its publication to cease.

INVESTIGATIONS BY THE STATE OF MISSOURI.

Up to this time we have seen that three States had given official support to scientific work on the subject of injurious insects, namely, Massachusetts, New York, and Illinois, although the Massachusetts support, as already shown, was of a most meager character. In 1868 the State of Missouri joined the list by the appointment as entomologist, of Charles V. Riley, who entered upon his duties on April 1 of that year, and published his first annual report the following December. From that date there followed, annually, eight additional reports, the ninth being submitted March 4, 1877, and covering the year 1876. At the time when Riley began his work, in spite of what had been done by the isolated labors of the men we have mentioned, the study of economic entomology in the United States compared most unfavorably with that in Europe. There elaborate works prepared by well-known naturalists had been published at Government expense, and smaller treatises on the subject of insects injurious to gardens, fields, and forests had frequently appeared, while the subject was taught in the numerous agricultural colleges and schools, especially in Germany. But with the beginning of the publication of the Missouri Reports, and perhaps even a little earlier—with the influence of the practical-minded Walsh, with whom Riley had been intimately associated for several years—the United States was about to begin a rapid progress in this direction, which ultimately placed her at the head of all other countries. Riley's nine reports were monuments to the State of Missouri, and more especially to the man who wrote them. They were original, practical, and scientific. They covered a very great range of injurious insects, and practically all the species which were especially injurious during those nine years received full and careful treatment. These reports may in fact be said to have formed the basis for the new economic entomology of the world, and they included a multitude of observations and intelligent deductions which have influenced scientific thought. Their value to the agriculturist, as well as to scientific readers, was greatly



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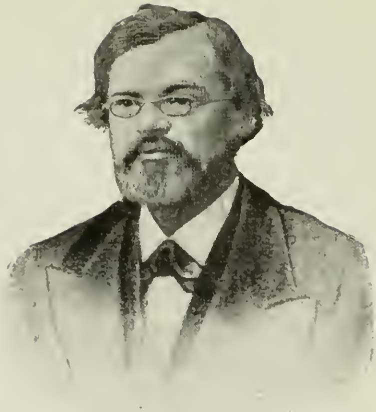
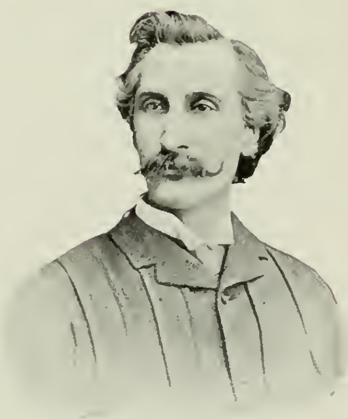


TOWNEND GLOVER.

T. WM HARRIS.

BENJ. D. WALSH.



C. V. RILEY.

SOME WORKERS IN ECONOMIC ENTOMOLOGY.

enhanced by a remarkable series of illustrations, which were drawn by the author and engraved upon wood by the most skillful wood engravers of that time.

BEGINNING OF A PERIOD OF GENERAL INTEREST IN ENTOMOLOGY.

While the Missouri Reports were being published, Dr. William Le Baron was appointed State entomologist of Illinois, an office which has been continued down to the present time, and the work of Le Baron and his successors, Cyrus Thomas and S. A. Forbes, has contributed in a marked degree to the progress of the economic application of entomology. During the Missouri period the well-known zoologist, A. S. Packard, acted as entomologist to the State board of agriculture of Massachusetts, and published three reports, covering the years 1871, 1872, and 1873; a number of young men also began to interest themselves in this line of work, and appreciation and interest on the part of the farming and fruit-growing population steadily grew.

In 1877 the United States Entomological Commission was founded by act of Congress and placed under the charge of the Secretary of the Interior, who appointed as members of the commission Charles V. Riley, A. S. Packard, and Cyrus Thomas. This commission, established for the purpose of investigating the ravages of the Rocky Mountain locust, or Western grasshopper, an insect which had destroyed the crops of certain Western States during the years 1874–1876, existed for several years and published five reports of lasting value, as well as seven bulletins.

In 1878, Townend Glover's health having failed, Riley, fresh from his successful labors in Missouri and from the completion of the first volume issued under the entomological commission, was appointed entomologist of the Department of Agriculture in succession to Glover. He held the office for a year and resigned, owing to a misunderstanding with the authorities. He was succeeded by J. H. Comstock, of Cornell University, who held the office for two years, when Dr. Riley again took charge of the Government entomological work, continuing until June, 1894. During the successive incumbencies of Riley and the intervening term of Comstock the Government work constantly improved, became more and more appreciated, and was an all-important factor in the development of public interest and appreciation. (For portraits of Harris, Fitch, Walsh, Riley, and Glover, see Pl. III.)

INVESTIGATIONS BY THE STATE AGRICULTURAL EXPERIMENT STATIONS.

A most important step was taken when the so-called Hatch Act passed Congress, under which agricultural experiment stations were established in all of the States of the Union. Most of the stations were organized in the spring of 1888. A number of entomologists were soon appointed and active work began practically in the month of February. The first entomological bulletin published by any of the experiment stations was issued in April, 1888, from the Arkansas station, by S. H. Crossman, and was entitled "The peach-tree borer and the codling moth." Bulletins from Hulst in New Jersey, Morse in California, Tracy in Mississippi, Ashmead in Florida, and Weed in Ohio, followed in May. Popenoe in Kansas, and Perkins in Vermont, published one each in June, and Fernald in Massachusetts, and Lugger in Minnesota, published one each in July. This movement, the importance of which to American economic entomology can hardly be overestimated, is too recent to require full historic treatment at this time. Activity in this branch of the work has increased with very great rapidity since 1888, and the character of the work done is on the whole better in almost corresponding ratio. Early publications were, largely as a matter of necessity, compilations. It was desirable to inform State agricultural constituencies of what was already known. With the gradual increase in libraries, laboratory facilities, and financial support, as well as appreciation on the part of farmers, opportunities for original investigation and experimentation have been gradually increasing until the present time. The majority of the entomologists of the State agricultural experiment stations are now in position to add to entomological knowledge and to do practical field work of value, and they are taking advantage of these facilities in a most praiseworthy manner. Of course, a large share of the influence of the work of these offices is gained through their correspondence with agriculturists and through addresses before farmers' institutes and other agricultural gatherings; but judging by the publications alone the gain has been very great. During the calendar year 1898, for example, sixty-one separate publications were issued by the different State experiment stations, either devoted entirely to matter on economic entomology or containing articles upon the subject, the total number of pages on applied entomology reaching nearly 1,400. During the same period nineteen separate publications on economic entomology were issued by the Department of Agriculture, containing a total of about 1,000 printed pages.

FOUNDING OF THE ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

The founding of the Association of Economic Entomologists in 1890 was an important step in the progress of the application of agricultural science. It has brought together in its annual meetings working economic entomologists of different parts of the country, placed them in personal relationship with one another, enabled them to discuss questions of general remedies, and has helped them to broaden their local entomological horizons. By virtue also of a regulation which admits to corresponding membership persons engaged in economic entomology in other parts of the world and which provides for the constant interchange of publications between all members of the association, the desirable object has been reached of a compact and rather intimately associated union of all the workers in all parts of the world engaged in this particular subject, a condition which it is believed does not exist in any of the other sciences as applied to agriculture. This broad movement, originating in the United States and carried on almost entirely by American workers, deserves special mention in an account of the progress made in this country.

DISCOVERY OF SAN JOSE SCALE IN THE EASTERN UNITED STATES.

An historical account of American progress in economic entomology in the present century would be a poor one indeed if it did not mention the one thing which perhaps more than any other aroused general interest in the subject and brought the economic entomologist most prominently to the front. We refer to the discovery of the existence of the San Jose scale in the Eastern United States in the year 1893. This insect, introduced into the United States from some unknown region, made its appearance in the vicinity of San Jose, Cal., late in the seventies. It spread rapidly over the State of California and was soon known as the most dangerous enemy to deciduous fruit trees on the Pacific coast. In 1887 or 1888 two innocent nurserymen living in New Jersey unwittingly brought it to the East upon nursery stock. Its presence was not discovered until 1893, when it had already been spread far and wide upon shipments of young trees. So great an industry had the sale of nursery stock become and so rapid was the multiplication of the insect that without another introduction of the scale from California the product of these two introductions into the East had in six or seven years been spread through portions of almost every one of the Eastern and Middle States. The scale established itself at almost every point where it was introduced except in certain northern localities, where the climate appears to have been too cold for its development, and it multiplied so excessively as to cause the death of thousands of trees before its presence became known. It was first found at Charlottesville, Va., and other infested localities were discovered in 1894. Warning publications were issued to fruit growers and nurserymen, and year after year discoveries of its occurrence in unsuspected regions multiplied until in 1897 and 1898 it was seen that there was hardly an important fruit-growing region in the United States which was not directly threatened by the pest. In the meantime there was the greatest activity with regard to the insect on the part of economic entomologists, agricultural and horticultural societies, agricultural journals, and State organizations. The literature relating to the insect became very great. Its bibliography by July, 1898, comprised several hundred titles of permanent record and several thousand titles in ephemeral publications. It occupied the attention of nearly every meeting of farmers and fruit growers that was held in the United States from 1894 to 1898, from the village club to the great State agricultural or horticultural society. It was the exciting cause of a national convention of fruit growers, farmers, entomologists, and nurserymen which was held in Washington, D. C., in the spring of 1897. It has been the subject of legislation in eighteen States of the nation and its suppression the principal object of two bills which were laid before Congress.

The general spread of this destructive insect worked great hardship to many fruit growers, and was the cause of the loss of many thousands of dollars; but looking at it in another way, the writer is firmly of the opinion that it has already been productive of great good and that its ultimate effect will be shown to have been most beneficial. Some of the State laws and the regulations which have been adopted to take effect under the provisions of these laws may not be wholly justified or thoroughly wise, but much beneficial legislation has been enacted, and no one cause has begun to operate so strongly as this in indicating the economic value of entomological knowledge and of Government support to entomological investigations, while the actual practical work which has been done against this insect by the small army of workers has greatly increased our knowledge of the action of insecticides, both upon insects and upon plants, and of the best methods of applying them.

PROGRESS IN REMEDIAL DISCOVERIES.

EARLY REMEDIES.

The remedial recommendations of the first sixty years of the century were on the whole not very valuable. A few common-sense suggestions were made, based upon a thorough knowledge of the life histories of certain insect pests, due almost entirely to the work of Harris and Fitch and in a lesser degree to the observations of Peck, although in this connection it should also be stated that excellent work was done on the Angoumois grain moth, or so-called fly weevil, of the South by two Southern planters, namely, Landon Carter and Edmund Ruffin. The majority, however, of the recommendations published in the agricultural journals and reports were theoretical and frequently nonsensical, seldom based on any accurate knowledge of the insect's life history, and sometimes derived from European sources. The following short list has been gathered in a haphazard way from publications of the period, and will serve to illustrate the general character of the recommendations:

To protect cabbages from the depredations of caterpillars.—Sow a belt of hemp seed around the borders of the ground when the cabbages are planted.—*New England Farmer, June 25, 1830.*

Cankerworms.—Use leaden gutters filled with some fluid over which the grub could not pass. Lamp oil is recommended.—*New England Farmer, July 13, 1831.*

Cankerworms.—Make a band of chestnut burrs by stringing them together with strong twine and tie around the trunk.—*New England Farmer, April 9, 1834.*

Bot-fly of the horse.—Scrape off the eggs every ten days with a sharp knife. Phlebotomize over the jugular vein and use mild oils freely.—*New England Farmer, May 5, 1826.*

Cankerworms.—Strew slacked lime an inch thick around the trees to the extent of 3 or 4 feet from the roots.—*New England Farmer, July 7, 1826.*

Cankerworms.—Tarring the trees.—*New England Farmer, July 25, 1828.*

Slugworms.—Dusting lime on the leaves by suspending an old seive on a long pole.—*New England Farmer, July 25, 1828.*

Rose-chafer.—Slacked lime applied from a dredging box while the fruits or plants are wet with dew, wetting the plants first with a weak solution of gum arabic.—*New England Farmer, May 8, 1829.*

Cankerworms.—Scrape the trees and tie on bands of hair rope.—*The Cultivator, April, 1838.*

Tent caterpillars.—Fasten a bottle brush (made to clean the insides of bottles and composed of hogs' bristles introduced between two stiff wires closely twisted) to a long pole, press it on the small nest, turning the pole in hand and tangling and removing the web.—*Timothy Pickering, in Massachusetts Agricultural Journal, Vol. IV, July, 1817.*

Pea weevil.—Let everybody feed all of their peas to their cattle and import a new stock of seed from Europe.—*William Bartram, in Memoirs Philadelphia Society for Promoting Agriculture, Vol. I, 1815 (read July 4, 1789).*

Plum curculio.—Suspend bits of board about the size of a case knife, dipped in tar, on the tree as a deterrent. Make a pavement about the tree by placing flat stones cemented with lime cement. Give hogs the run among the trees to destroy the fallen fruit.—*William Bartram, in Memoirs Philadelphia Society for Promoting Agriculture, Vol. I, 1815, Appendix, pp. 34–38.*

Hessian fly.—Destroy the stubble of grain soon after harvest by burning or otherwise.—*Jonathan N. Haydens, in Transactions Society for Promotion of Agriculture for New York, Vol. I, 1792, pp. 89–107.*

Caterpillars on trees (presumably tent caterpillars).—Bore a hole into the tree about 6 inches deep and fill it with sulphur, a remedy which is said to have never failed. Several cases instanced.—*George Webster, Albany, in Memoirs Board of Agriculture State of New York, Vol. II, 1823, p. 251.*

All insects on trees.—Sulphur plug.—*Farmers' Register, Vol. 1, 1834, p. 149.*

Moths in wheat.—Mix large parcels of the twigs of the China tree with the wheat. In one fortnight, on experiment, not a weevil was to be found.—*Farmers' Register, Vol. I, 1834, p. 227.*

Hessian fly.—Late sowing.—*Farmers' Register, Vol. I, 1834, p. 310.*

Peach-tree borer.—Remove the soil around the base of the trunk, put in a composition of clay and ashes, and wrap stiff brown paper around the tree to the height of a foot.—*Farmers' Register, Vol. I, 1834, p. 417.*

A rather elaborate article was published as a prize essay of the New York State Agricultural Society in 1843[1] under the title "A treatise on insects injurious to field crops, fruit orchards, vegetable gardens, and domestic animals, with a description of each and the best methods of destroying them or preventing their ravages." This essay, which covers about fifty pages, contains practically nothing original, and some of the remedial recommendations are rather amusing. For example, in writing of the wheat midge, the author says: "Fumigating the fields with sulphur or smoke from any materials will retard their action for a time, and, could it be continued, might destroy them.

[1] Transactions New York State Agricultural Society, Vol. III, 1843.

All pungent odors are offensive to the grain fly, as they are to the mosquito, and that most offensive of all odors, the one proceeding from the skunk, has been tested and highly recommended as a preventive."

It was this sort of work that especially aroused the indignation of Walsh. The caustic manner with which he showed up the unfounded utterances of impractical and ignorant persons may be illustrated by his comment upon a newspaper article which recommended banding trunks of trees as a remedy for all the insects which injure trees:

> The worm in fruit trees! As if fruit trees were not afflicted by hundreds of different worms, differing from each other in size, shape, color, and habits of life, time of coming to maturity, etc., as much as a horse differs from a hog. Yet the universal bandage system is warranted to kill them all. Does the apple worm bore your apples? Bandage the butt of the tree, and he perisheth forthwith. * * * Does the web worm spin his web in the branches? Bandage the butt, and he dieth immediately. Does the caterpillar known as the red-humped prominent or the yellow-necked worm strip the leaves off? Bandage the butt of the tree, and hey! presto! he quitteth his evil ways. Does the Buprestis borer bore into the upper part of the trunk? * * * Still you must bandage the butt with the same universal calico, and in a twinkling he vamoseth the ranch. Be the disease what it will, the universal, patent, never-failing pill is certain sure to extirpate it. * * * In obstinate cases it may perhaps be necessary to bandage the whole tree, trunk, branches, twigs, and all; but if you only apply bandages enough, the great bandage anthelmintic vermifuge is sure to be a specific against the genus worm. The genus bug may perhaps require a distinct prescription: something in the nature of a cataplasm or an emollient lotion. * * * Long live King Humbug! He still feeds fools on flapdoodle, and many of them have large and flourishing families, who will perpetuate the breed to the remotest generation.

A NEW ERA IN REMEDIES.

With the writings of Walsh, immediately followed by those of Riley, a new era of excellent remedies founded upon accurate knowledge of the economy of the insects in question began. Aside from the excellent recommendations which had been made with regard to agricultural practice, as it has been termed, and which refers to such matters as rotation of crops, different times of planting and harvesting, and different methods of cropping, etc., the first great start which the new economic entomologist received from the remedial standpoint was probably the introduction of Paris green as an insecticide.

Paris green.

At the time this substance was introduced, the best insecticides in use were the various forms of soap, tobacco, quassia chips, carbolic acid, and hellebore, although the last was a comparatively new remedy and came into general use at about the time of the spread of the imported currant worm in the late fifties. The spread of the Colorado potato beetle into the Eastern States between the years 1859 and 1872 started a great deal of experimental work in regard to remedies, and Paris green was first used at some time early in the sixties. The name of the first man to use it is not known, but by 1868 it was being used by several persons. The editors of the American Entomologist

(Vol. I, p. 219, July, 1869) recommended it confidently as a result of experiments tried both in 1868 and 1869, and in the former year Mr. J. P. Wilson, of Illinois, took out a patent for one part Paris green and two parts mineral paint, to be used to kill potato bugs. The use of Paris green against the cotton caterpillar seems to have been first suggested by Riley at the St. Louis meeting of the National Agricultural Congress in 1872, although in January, 1871, T. W. Mitchell, of Texas, secured a patent for the use of a solution of arsenic against this insect. Its extensive use against the cotton caterpillar has been a great boon to the cotton planters of the South.

In 1872 Dr. Le Baron recommended the use of Paris green against the spring cankerworm, which was abundant that year. This was the first recommendation for its application to fruit trees. Four years later Prof. A. J. Cook repeated the recommendation, and in 1878 the advice was followed by many apple growers in Michigan. In 1878 Mr. J. S. Woodward, of Lockport, N. Y., advised Mr. Edward P. Haynes, of Niagara County, N. Y., to spray his apple trees with Paris green against cankerworms. The following autumn Mr. Haynes noticed that the apples in the sprayed part of the orchard were much less infested by the codling moth than in other parts of the orchard. Mr. Woodward visited the orchard, verified this fact, and reported it at the January meeting of the Western New York Horticultural Society. Mr. Woodward, writing to the late E. G. Lodeman, when the latter was engaged in preparing his work entitled "The spraying of plants," said: "I shall never forget this, because of the way in which I was jumped upon as a crank." Almost at the same time the same discovery was made by Professor Cook, in Michigan, and by Hon. John M. Dixon, of Oskaloosa, Iowa, the latter, however, using London purple instead of Paris green.[1] This discovery has resulted in the use of arsenical poisons in enormous quantities in regular orchard work. It was adopted slowly, on account of the supposed danger from its use. Even Riley, who had been so prominent in urging the use of arsenical poisons against the Colorado potato beetle and the cotton caterpillar, writing in the Farmers' Review, in the autumn of 1880, says:[2]

Professor Cook, of the Michigan Agricultural College, has lately recommended them [Paris green and London purple] for the killing of a strawberry leaf-beetle (*Paria aterrima* Oliv.), which, as he shows, lives in its larva state beneath the ground; also for the destruction of the apple worm. In the first instance it were eminently dangerous to use such a poisonous remedy while the plants are fruiting, and I would not recommend it even later in the season until every other available remedy had been tried. In the second case it is even less to be recommended. It will undoubtedly serve to kill many of the first brood of worms, and this is desirable; but there is as good evidence that lime or plaster dusted onto the young

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[1] See the writer's article on the codling moth, in the Annual Report of the Department of Agriculture, 1887, pp. 88–115, for a discussion of this question.

[2] See American Entomologist, Vol. III, p. 244.

fruit has much the same effect, while experience has shown that the bandage system and other methods of fighting this ins ct, when judiciously and persistently adopted from year to year, are sufficient to insure a crop at trifling cost. Finally, if the poison is so persistent in the calyx as to have any effect in destroying the second brood of worms, that will only heighten the danger to those persons who subsequently eat the fruit.

Professor Cook, in a paper read before the American Association for the Advancement of Science at its Boston meeting, in 1880, as well as in subsequent papers read before the Michigan Horticultural Society and the Society for the Promotion of Agricultural Science, gave his annual experience, and was the most ardent advocate of this treatment for codling moth. The careful experiments made by Forbes in 1885 added great weight to the remedy, on account of his wide reputation for care and conservatism. E. S. Goff, then at Geneva, N. Y., also published results of some careful experiments made in 1885. In 1887 experiments made by W. B. Alwood and E. H. Cushman for the Division of Entomology emphasized the value of the treatment, which the writer did not hesitate to strongly recommend in his article on the codling moth, published that year. As Lodeman has shown, however, very few of the most progressive orchardists adopted the remedy until after the establishment of the State agricultural experiment stations in the spring of 1888, when added emphasis was given by the experiments and recommendations of the newly appointed entomologists and horticulturists.

The same substance, Paris green, was first recommended against the plum curculio by Mr. G. M. Smith, of Berlin, Wis., in 1871, but the idea that it would be efficacious was generally discredited. Mr. J. Luther Bowers, of Herndon, Va., used it in 1880 with good results. Mr. William Creed, of Rochester, N. Y., recorded the complete success of two years' work against the insect in Purdy's Fruit Recorder, in November, 1885, and during the same year Forbes experimented most carefully in Illinois. In 1887 W. B. Alwood and Herbert Osborn, working for the Division of Entomology; A. J. Cook, in Michigan, and C. M. Weed, in Ohio, also carried out successful experiments, and the remedy has since come into general use. By 1887, in fact, arsenical poisons had become the standard remedy against nearly all mandibulate or gnawing insects. Their use in other countries has been brought about very slowly, and they have but slight vogue in Europe to-day. Miss Ormerod, in her numerous reports, has recorded the difficulty which she has experienced in securing their adoption by English orchardists. The English colonists, however, more enterprising and less conservative than the home people, have taken them up, and they are used to-day in New Zealand, Australia, and South Africa.

Arsenical compounds.

Much experimental work with different arsenical compounds has been carried on in the United States since Paris green made its appearance. London purple, a by-product in the manufacture of aniline dyes, was introduced through the efforts of a London house in the early eighties, and it has been used to a very considerable degree. Its peculiar color was considered a strong argument in favor of its use on account of the ease in distinguishing sprayed plants and on account of its ready recognition as a poison. This latter argument failed in one instance, at least, as was pointed out by the late Dr. W. S. Barnard, who, on one occasion, while traveling on a Mississippi River steamboat, discovered that the London purple sifting through sacks in the cargo had been used by the enterprising steward to color the ice cream which was served to the passengers. The variable amount of arsenic contained in this compound, however, renders it a less satisfactory substance to use than some of the other arsenical combinations. The use of common white arsenic, especially when mixed with lime, has been recommended, and its experimental use in this combination was first tried and advocated by Gillette when connected with the Iowa experiment station. A compound known as arsenate of lead has come into somewhat general use in the last few years. This substance was first used by the gipsy-moth committee of the Massachusetts State Board of Agriculture in its work against the gipsy moth, an insect which is able to consume a considerable quantity of arsenic without harm, from which fact a poison was needed which could be sprayed upon the trees in very strong solution. The lead compound enabled its use in great strength without the ordinarily resulting damage to the foliage. Later compounds are the simple arsenite of copper, first recommended by Mr. C. L. Marlatt, of this office, and a mixture recommended by Professor Kedzie, of the Michigan Agricultural College, in the following proportions:

White arsenic	pounds	2
Sal soda	do.	4
Water	gallons	2

Boil together for fifteen minutes; then slake 2 pounds of lime and stir it in 40 gallons of water, adding a pint of the above mixture.

The simple arsenite of copper is preferable to Paris green on account of its smaller cost and in being a very fine powder, which remains easily in suspension. It contains about 50 per cent of arsenic, and is marketed under the name of green copper arsenite.

Kerosene emulsions.

Another distinct and very important advance in the line of remedial application was the general adoption of kerosene, emulsified so as to stand dilution with water, against sucking insects. The insecticide properties of pure kerosene have long been known. Lodeman has shown that kerosene was recommended for the destruction of scales on orange trees in 1865,[1] and was also successfully applied to

[1] Gardeners' Monthly, December, 1865, p. 364.

oleander, sago palm, acacia, and lemon trees. This, however, was only greenhouse work, as the oil was poured into a saucer and applied by means of a feather. The Gardeners' Monthly the following year recommended it for destroying all insect life, but modified this recommendation later by the statement that the vegetable oils were safer. Mr. William Saunders, of the Department of Agriculture, told the writer, in 1878, that he had been using a mechanical mixture of kerosene and water in greenhouse work for many years. Mr. George Cruikshank, of Whitingsville, Mass., used a mixture of kerosene and whale-oil soap as early as May, 1870, practically producing an emulsion.[1] Henry Bird, of Newark, N. J., in 1875, made a mixture in which he used a little kerosene oil with strong soapsuds, finding that it combined readily, and could be applied uniformly with a syringe.

In 1878 A. J. Cook[2] recommended a mixture of kerosene oil and soapsuds. In 1880 W. S. Barnard, working for the United States Entomological Commission, suggested and produced an emulsion of kerosene with milk, which was used with some success. In the winter of 1881–82 H. G. Hubbard, working for the Division of Entomology, made a stable milk emulsion with condensed milk, which he used successfully against scale insects on orange trees, and in 1884 the same investigator originated by experiment the standard kerosene-soap emulsion now commonly known as the "Riley-Hubbard formula." Cook, working in Michigan, had arrived at a different formula, and his failure to make a good emulsion by the "Riley-Hubbard" formula was shown by Marlatt to be due to the exclusive use of very hard water at the Michigan Agricultural College. This kerosene-soap emulsion, generally made according to the so-called "Riley-Hubbard formula," was speedily adopted, and has become one of the most used and most reliable insecticides against all sucking insects. (See Yearbook for 1896, footnote to page 232, for mention of a possible earlier use of kerosene emulsion.)

Hydrocyanic-acid gas.

Another very important insecticidal process which has come into use during the last fifteen years is that of fumigation with hydrocyanic-acid gas, although the introduction of this process has had by no means the same far-reaching effects as the discovery and general use of arsenical poisons and kerosene emulsion. The process originated in California as the direct outcome of the efforts of this office against scale insects, the original work being carried on by D. W. Coquillett, a field agent of the Division of Entomology, and F. Morse, of the University of California, and subsequently largely by private enterprise, although experimental work in different modifications of the process was done by Mr. Coquillett, or under his supervision. The plan of covering trees with oiled tents and liberating beneath the

[1] Gardeners' Monthly, February, 1875, p. 45.

[2] Report of the Michigan State Board of Agriculture for 1878, p. 434.

tents a supply of this deadly gas, produced by treating cyanide of potassium with sulphuric acid, was adopted by citrus growers and by county horticultural commissioners to a very considerable extent in California. Its use was practically restricted to this State down to 1895, although some experiments had been made with its use on the island of Montserrat, British West Indies, against scale insects on orange and lemon trees in 1894–95, upon the recommendation of Professor Riley, who visited this island in company with Mr. Hubbard in the spring of 1894. With the development of the San Jose scale work in the East, however, this process was soon introduced in this part of the country. The first experiment made with it was undertaken by Mr. Coquillett on the grounds of Dr. C. H. Hedges, of Charlottesville, Va. (the first point where the San Jose scale was discovered east of the Rocky Mountains), in the month of March, 1894, and the writer of this paper in April, 1894, described the process without especially recommending its use, as at that time the results of the Charlottesville experiment had not become apparent.[1] More recently the process has been carried on, apparently with great success, in Maryland orchards by Prof. W. G. Johnson.

A great and important development of the use of this fumigating process, however, soon took place in its application by nurserymen to their stock before delivery to purchasers. This process, adopted by many nurserymen for self-protection and required by the laws of certain States, was, the writer believes, first recommended by him in conversation with Dr. J. B. Smith, entomologist of the New Jersey Agricultural Experiment Station, in September, 1894, while visiting the nurseries of the Parry Brothers, in New Jersey. Its use in this way was recommended in Bulletin No. 3, new series, of the Division of Entomology, but in the meantime it had been recommended by Dr. Smith in Bulletin No. 106 of the New Jersey station, published November 22, 1894. To Dr. Smith, therefore, belongs the credit of the first published recommendation. Since that time the process has come into very general use. Experiments by Alwood in Virginia and by Johnson in Maryland have resulted in the fixing of methods and in the establishment at many points of buildings erected for the sole purpose of fumigating nursery stock.

Another form of the use of hydrocyanic-acid gas against insects has received consideration during the past five years and has now reached practical results; this is its application against insects affecting greenhouse plants. The greenhouse itself, being a closed building or a building which may be closed, renders the use of the gas at night a comparatively simple matter, but the great variety of plants of varying resistant qualities which are found in greenhouses has rendered necessary extended experimentation in order to insure safety to the plants themselves. The extended work of Messrs. Woods and

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[1] Circular No. 3, second series, Division of Entomology, published April 4, 1894.

Dorsett, of the Department of Agriculture, and Mr. Hemenway, of the Massachusetts Agricultural College, as published by the Division of Entomology, has established the usefulness of this application within certain limitations. It seems, however, that specific experiments under all possible varying conditions and upon all possible varieties of plants must be made before the remedy can come into general use.

The three main insecticide discoveries.

The use of arsenicals, of kerosene emulsions, and of hydrocyanic-acid gas are the main insecticide discoveries of the closing portion of the century, and their use as practiced to-day has been dependent upon a great amount of experimental work, carried on, perhaps, mainly by economic entomologists. This experimental work included not only a consideration of the proper proportions of the insecticides when used against different insects, but also a determination of their effect upon the foliage of different plants in different climates, under different local climatic conditions, in different seasons, and even at different times of the day, as well as different methods of preparation involving the points of ease and economy.

Experimental work with other insecticide substances.

A great deal of valuable experimental work has been done also with other substances and mixtures. This work has been of value, even where the results have been negative, as forestalling future labor and especially as putting a quietus upon unfounded recommendations and upon valueless proprietary claims. The extensive experiments with pyrethrum mixtures, for example, which resulted in the establishment of an extensive industry in home-grown pyrethrum powder and in a large series of tests in growing *Pyrethrum roseum* and *P. cinerariæfolium;* the extensive experiments with different whale-oil and fish-oil soaps, begun originally in the work of the Division of Entomology against the hop plant-louse in 1886 and carried on much further in 1895–96 in the work against the San Jose scale; the experimental work with the old quassia chips solutions and decoctions; the series of experiments with supposed insecticidal native plants, and a host of other experiments of similar nature may be cited as evidence of the extent of this work. Probably the most important of the remedies of what may be termed secondary value, and which have been brought forward by this work of recent years, is the use of bisulphide of carbon against insects affecting stored grain.

Machinery for distributing insecticides.

The development of machinery for the application of insecticide mixtures is another great advance in applied entomology made during the past twenty years; and this is a line of work in which especially the horticulturist and also the vegetable pathologist have had a hand. This work first became prominent in the investigations undertaken by the Government both under the Division of Entomology, Department of Agriculture, and under the United States Entomological Commission in the work against the cotton caterpillar in the South.

It is true that in the early days of the march of the Colorado potato beetle toward the East a number of sprinklers and dusters were invented for the purpose of applying Paris green to potato plants; and two or three of these, like "Gray's improved sprinkler," invented by Frank M. Gray, of Illinois, in 1874, and "Peck's spray machine," invented by W. P. Peck, of Pennsylvania, about the same time, were prophetic of the improved knapsack sprinklers which have come into such great use, especially for diseases of the grape in France, and also to a lesser degree in this country. But it was not until the late W. S. Barnard, working under the direction of Riley, invented the admirable eddy chamber, or "cyclone system" of nozzles, following it with the construction of a number of ingenious, but since superseded, machines for the field distribution of the poison that what may be termed the "insecticide-machinery epoch" began. This work was soon after taken up in France, where it has been carried to a high degree of excellence by such firms as V. Vermorel and others, Vermorel inventing a modification of the cyclone nozzle, known there as the Vermorel modification of the Riley nozzle and in this country as the Vermorel nozzle. It was not, however, until the use of arsenical sprays in orchards, against the codling moth in particular, and also against the plum curculio and the cankerworm, became general that the full tide of perfection of insecticide machinery began. As was quite to be expected, so soon as there was a strong demand for such improved machinery intelligent manufacturers took hold of the problem and began to place machines of great excellence on the market. The demand increasing, improvement became more and more abundant, and there are at the present day many firms in the United States putting out distributing machines of a high degree of merit and of almost unending variety, from the hand bucket pump for garden use to the motor engine pumps and machinery for orchard use on a large scale. Many nozzles have been invented since Barnard produced his first rough tin model of the eddy chamber, or "cyclone," as he termed it, but the modifications of his system remain to-day the most generally used and the most efficient and economical of any that have been produced.

WORK OF AN INTERNATIONAL CHARACTER.

In 1889 was brought about by American entomologists the first example of what may be termed beneficial international work in economic entomology. The introduction of *Novius* (*Vedalia*) *cardinalis* from Australia into California, where it utterly destroyed the white or fluted scale, an insect which had damaged the citrus crops of California to the extent of hundreds of thousands of dollars, and which threatened the extinction of the citrus industry of the Pacific slope, is an event which is too well known to need description here. It was also an event which has been termed "epoch-making," and which would deserve the title could it only be often repeated. It opened up, however, in a practical way a line of work which had often been suggested by American writers on entomology (the first of them, by the way, it must be stated, being a Canadian, Rev. C. J. S. Bethune).

The first and successful importations of this beneficial ladybird were made by Albert Koebele, a salaried agent of the Division of Entomology, working under the direction of the late Dr. Riley, but whose traveling expenses were defrayed from the fund appropriated by Congress for the representation of the United States at the Melbourne Exposition. A later trip to Australian regions was undertaken by Mr. Koebele while still on the pay rolls of the Division of Entomology, but his expenses were paid from the appropriation granted by California to its State board of horticulture. The results of this second trip, although not as conclusive as those of his first trip, still demonstrated in marked degree the advantage of this class of international work, namely, the introduction of beneficial insects from one country to another. After Koebele's second trip he resigned his position, and was soon after employed by the newly established Hawaiian Republic for the purpose of continuing the same class of work for that country. From reliable accounts it seems certain that his work along the same line has resulted in great benefit to the agricultural interests of Hawaii, which, since its annexation to this country, has once more made Koebele's work a feature of the economic entomology of the United States.

The United States has been able to assist other Governments in their work against injurious insects. Sendings of the same ladybird (*Novius cardinalis*) to South Africa, to Egypt, and later to Portugal, have brought about results similar to those which proved the salvation of the citrus industry of California, while other less important exportations of beneficial insects promise good results. Through the office which the writer represents there have been several introductions of beneficial insects from foreign countries. Collections of museum specimens of injurious insects of foreign countries have also been made and brought to this country in the course of a study of the greatly increasing danger which enlarging commercial relations and rapidity of ocean traffic are constantly bringing about by the introduction of new insect pests.

A striking exemplification of the benefits to be derived from the prosecution of this international work is actually developing in California in the probable establishment in that State, through the efforts of this Department, of *Blastophaga grossorum*, an insect which in Mediterranean countries fertilizes the Smyrna fig, and which it is confidently expected will result in the building up of a fig industry in California, the output of which will rank favorably with, if it does not exceed, that of the countries which have made the Smyrna fig the standard fig of commerce. At the time of the present writing (December, 1899) four generations of the fertilizing insect have been reared under natural conditions at Fresno, Cal., and there is every probability that it will be carried through the winter successfully. The insect hibernates in so-called gall-figs upon the wild fig tree. Such figs heretofore at Fresno have fallen with the first heavy frost. The present winter, however, a certain number of trees have been protected from the action of the frost by a canvas covering, and a commercial product of American-grown Smyrna figs during the summer of 1900 is confidently expected.

PRESENT STANDING OF THE UNITED STATES IN ECONOMIC ENTOMOLOGY.

The writer has referred in an earlier portion of this paper to the fact that as late probably as 1878 this country was behind certain European countries in its accomplishments in the field of economic entomology, but owing to the crying needs of a rapidly growing population of practical people and to the consequent encouragement given by legislatures in making appropriations, as well as by the energy, ability, and adaptability of the individual workers, many of them men of high standing in the field of pure science, the United States has jumped to the front. English colonists, themselves confronting many of the same problems which we have had to meet, were among the earliest to recognize this fact, and agricultural papers of the Australian colonies, of New Zealand, of Cape Colony, and of British India have for years been extensively quoting from American writings. Other countries have followed their lead. Cape Colony has employed an American economic entomologist. Argentina sent for an American entomologist to advise that Government in its work against migratory locusts. The British West Indies are at the present time in search of the proper man to go from the States to help them in their work along these lines. In 1896 the French authority, Dr. Paul Marchal, writing on the subject of applied entomology in Europe, began his paper with the words (freely translated):

> There exists nowhere an organization dealing with applied entomology capable of rivaling that of the United States. The extraordinary development which this service has taken in America is well known. * * * The progress realized in these later years under the influence of this organization has been of the highest kind. In particular that which concerns the application of insecticides on a large scale and biological observations of a high interest from the point of view of pure science have been accumulated in their publications. * * * European nations have commenced to follow the example which has been given to them on the other side of the Atlantic. * * *

Recently, Miss Eleanor A. Ormerod, the well-known English writer and investigator, referring to the work of American economic entomologists, wrote: "It really is impossible for me to say how highly I fully believe that their serviceable scientific and applied information is benefiting the world as well as their own country."

All this is encouraging, and it appears to the writer, who, however, is perfectly willing to confess that he may be prejudiced, well deserved; yet the rapid strides which other countries are taking will necessitate the most strenuous endeavors on the part of American workers if this temporary supremacy is to be maintained. This, of course, should not be an especial aim of economic investigators in this country, but is perhaps worth the mention. We shall aim to secure the best results possible, and it should be our hope that others in other countries may do as well. The extremely rapidly growing public interest in investigations in this line during the past few years, as well as the excellent results obtained by the workers, are fast placing this country in a position where agriculturists may work to the best advantage in their warfare against injurious insects.

AGRICULTURAL EDUCATION IN THE UNITED STATES.

By A. C. True, Ph. D.,
Director of the Office of Experiment Stations.

INTRODUCTION.

In previous articles in the Yearbooks for 1894, 1897, and 1898 the origin and development of the system of agricultural education in the United States have been discussed, and special features of that system have been described in more or less detail. The main purpose of the present article is to present a general view of the different agencies for education in agriculture in this country as they exist at the close of the nineteenth century, and to indicate the directions in which the movement for the diffusion of knowledge on agricultural subjects among our people is tending. In order that the reader may have a proper understanding of the real significance of the present remarkable activity in the sphere of agricultural education, it is necessary that he should have in mind at least an outline of the history of this movement, and be able to form some estimate of the progress which has been made in defining and organizing the various branches of agricultural education. In presenting such an outline as an introduction to the main theme of this article, advantage will be taken of a recent review of the available literature relating to the history of agricultural education in this country made under the direction of the writer by Prof. Herman Babson, of the Massachusetts Agricultural College, through which additional light has been thrown on the beginnings of various important movements for the promotion of such education.

The activity in agricultural education during the present century will seem all the more impressive if it is remembered that, after the cessation of the efforts of Greek and Roman writers to encourage agriculture by describing the processes of the art, centuries elapsed before the educated men in Europe took interest enough in agriculture to write books about it. War was the chief occupation of gentlemen, and the arts of peace were left to the ignorant and the lowly. But these centuries nevertheless marked the steady progress of civilization, and "soon after the beginning of the sixteenth century agriculture partook of the general improvement which followed the invention of the art of printing, the revival of literature, and the more settled authority of government, and, instead of the occasional notices of historians, we can now refer to regular treatises, written by men who engaged eagerly in this * * * occupation." The first English treatise on husbandry appeared in 1534, entitled "The book of husbandry," and was written by Sir A. Fitzherbert, a judge of common pleas. The voyages of exploration in various hitherto unknown quarters of the globe and the colonization of America brought new agricultural plants and breeds of animals to Europe and caused the spread of the old ones in the new countries. The natural sciences were rapidly developed and investigations relating to agriculture began. Something of the progressive spirit of the age begun to stir in even the dull frame of this oldest of industries, and by the close of the eighteenth century the advance movement in agriculture had taken the form of organized effort. Societies, like the Bath and West of England Society and the Highland Society, were formed in Europe, and a Government board of agriculture was organized by Great Britain.

EARLY EFFORTS FOR THE IMPROVEMENT OF AGRICULTURE.

In this country the first agricultural efforts necessarily were directed toward clearing the land and growing the crops immediately needed for the sustenance of the settlers and for export to the mother country, whence alone manufactured articles could be obtained. As is common in new countries where vast tracts of land are open to free occupation, many speculative attempts were made to grow crops bringing high prices with a minimum of labor. Some of these attempts, like that relating to the production of silk, proved utter failures, while other crops, such as tobacco, were very profitable. Land was so plentiful that in many regions the easiest and most profitable thing to do when yields declined was to change to new fields and abandon the old to weeds. There was little incentive to careful cultivation and scarcely any motive for seeking new knowledge for the improvement of agricultural practice; and to this can be added the general absence of any educational system for the masses, together with the deep-rooted prejudices against "book learning" as applied to any industrial pursuit, especially agriculture. Wars, at first with the Indians and then between the various European nationalities occupying the American continent, engaged much of the attention of the most vigorous portion of the farming community, and these struggles culminated in the united efforts of the colonies to free themselves from Great Britain, which led to the protracted contest known as the American Revolution.

Occasionally some pioneer of agricultural education arose, like Jared Eliot, of Connecticut, who published in 1747 a series of essays on farming "full of valuable suggestions," but little heed was paid to the advice of such men. The Revolution naturally left agriculture in a most deplorable condition, so that the attention of statesmen was almost necessarily drawn to measures for its resuscitation. But far more important for the begetting of a progressive movement in agriculture was the new feeling among the people that this country was to be forever the home of themselves and their descendants. They were no longer adventurous colonists seeking wealth to be taken back to the mother country, but citizens of a young nation with vast possibilities of material development. It was also evident that for a long period agriculture would be the chief industry of the new Republic, and that the development of other industries, as well as success in commerce, depended largely on wise utilization of the agricultural resources of the country. The wisest heads took in the real situation most quickly, and, following the fashion set across the sea, begun a propaganda for agricultural improvement. This was not due to any demand of the people for information, but to a desire on the part of the leaders of thought and action to awaken interest in what they deemed a matter of vital importance to the welfare of the nation. Hence, most of the early agricultural societies were begun in cities, and their membership was largely composed of men who had only a secondary interest in agriculture, though it must be remembered that in those days there were comparatively few Americans in active business, professional, or political life who did not have some direct dealings with farm property.

ORGANIZATION OF AGRICULTURAL SOCIETIES.

The organization of agricultural societies, beginning early in 1785 at Philadelphia, then the national capital, and taking in such men as George Washington, Benjamin Franklin, and Timothy Pickering, spread rapidly south and north along the fringe of Atlantic coast communities, then constituting the United States. At Charleston, S. C., in 1785; Hallowell, Mass. (now Maine), in 1787; New York City, in 1791; Boston, Mass., in 1792; Wallingford, Conn., in 1794; Middlesex County, Mass., in 1794; Sturbridge, Mass., in 1799, and perhaps in a few other places, similar societies were formed prior to the close of the eighteenth century. This movement continued, until in 1809 we have the germ of a national organization in the society formed in the District of Columbia, to which the seat of the National Government had a few years before been permanently transferred.

BEGINNING OF PUBLICATIONS ON AGRICULTURE.

During this period various methods for diffusing agricultural information were proposed or put in operation, very largely through the efforts of these agricultural societies. Books on agricultural subjects began to appear. Among these, mention may be made of a volume of over 300 pages, published at Worcester, Mass., in 1790, entitled "The New England Farmer, or Georgical dictionary: Containing a compendius account of the ways and methods in which the most important art of husbandry, in all its various branches, is or may be practiced to the greatest advantage in this country, by Samuel Deane, A. M., Fellow of the American Academy of Arts and Sciences;" and the "Rural Socrates, or an account of a celebrated philosophical farmer, lately living in Switzerland and known by the name of Kliyogg.—Hallowell (District of Maine). Printed by Peter Edes, and sold by the booksellers in the principal towns of the United States. A. D. 1800." The author of this book was Dr. Vaughan, a prominent member of the Maine Agricultural Society, who, in 1803–1804, likewise published a series of agricultural papers and essays of much value.

The more important societies soon began the publication of information on agricultural subjects. As early as 1792, the New York society published a small quarto volume of its transactions. In 1797 the trustees of the Massachusetts society began the publication of pamphlets, or, as we now say, bulletins, on agricultural topics, which afterwards were developed into a regularly issued journal. The same year this society established "a regular library," having accumulated, "by gift and purchase, a considerable number of works on agriculture."

ESTABLISHMENT OF FAIRS FOR EDUCATIONAL PURPOSES.

Four years later (1801) a communication was presented to the trustees of the Massachusetts society which contained the germ of an educational movement on behalf of agriculture, destined to have an important influence on the improvement of the art in this country, especially down to the opening of the civil war. This was the suggestion that fairs should be held in May and October in Cambridge common and "small bounties given for certain articles." Nothing was immediately done to carry out this plan; but in 1804, Dr. Thornton, the first United States Commissioner of Patents, proposed that fairs should be held in the city of Washington on market days, after the English fashion. This idea was eagerly taken up by the citizens and municipal authorities, and the first fair was held in October of that year. It was such a decided success that two others were held in succeeding years, after which, however, they were discontinued. A great impetus seems to have been given to this movement by the enthusiastic labors of Elkanah Watson, of Massachusetts, who, beginning with an exhibition of two merino sheep on the public square at Pittsfield in 1807, soon developed the more elaborate and picturesque "cattle shows," which for many years were the popular rural festivals, especially in New England. Much interest also attaches to the "sheep shearings," the most famous of which was annually held for a dozen years, beginning with 1808, by George Washington Parke Custis, at "Arlington," his estate near Washington, on the Virginia bank of the Potomac. This was attended by throngs of prominent men, and had much social as well as agricultural importance. The interest in the movement for the promotion of agriculture awakened at the national capital is further shown by the organization in 1809 of the Columbian Agricultural Society, which was the foundation of the national organization finally formed in 1852. From 1809 to 1812, inclusive, this society held six fairs, at which cattle, woolen goods, cotton cloth, fancy work, clothing, bed linen, sewing thread, carpeting, rugs, dyes, etc., were exhibited.

THE BEGINNING OF AGRICULTURAL EDUCATION.

Washington's deep interest in measures for the advancement of agriculture is evidenced not only by his letters but by his message to Congress in 1796, in which he earnestly pleads for the establishment of a national board of agriculture. Congress, however, took no decisive action on this proposition.

Meanwhile definite efforts had been made to secure for agriculture a place in the school system of the country. From the Transactions of the New York Agricultural Society we learn "that the legislature by an act passed April 11, 1792, had granted the sum of L.750 (£1,500) for five years to the trustees of Columbia College for the purpose of endowing additional professorships, and that the trustees had instituted, among others, a professorship for natural history, chemistry, and agriculture, * * * and that lectures had been given upon the different parts of the course." Samuel L. Mitchill, M. D., LL. D., an active member of the society, was elected to this professorship, probably on the recommendation of Dr. Samuel Bard, another member, who chanced to be a trustee of Columbia College. How far agriculture was directly taught by Dr. Mitchill we do not know, but we have his assurance that in the course in botany which he gave "the physiology of plants, including their food, nourishment, growth, respiration, perspiration, germination, etc., is therefore particularly enlarged upon as connected with gardening and farming." He also wrote essays on the chemistry of manures.

In 1794 the Philadelphia society received the report of a committee in which the claims of education in agriculture through the establishment of professorships in the colleges, as well as the teaching of agriculture in the common schools, are urged upon the attention of the State legislature.

In 1801 the Massachusetts society subscribed $500 for the establishment of a professorship of natural history in Harvard College, and a committee was appointed to obtain subscriptions for the permanent endowment of this professorship and for the support of a botanic garden. This resulted in the election of William D. Peck, in 1804, to fill the new chair, and in the later establishment of the botanic garden.

"Just as the country was well started toward helpful discussions and improvements along agricultural lines," says Professor Babson, "the second war with England placed many hindrances in the way of further progress in this direction, and these hindrances were subsequently strengthened by the rapid growth of manufacturing facilities and wealth-seeking industries. The tendencies of the times were citywards, and the era of good feeling naturally became an era unfavorable for great agricultural advancement. Nevertheless, the farmers and their friends, clearly understanding the unsatisfactory state of affairs, did what they could in spite of the indifference of the general public regarding their efforts." The formation of agricultural societies was continued and their number rapidly increased. In South Carolina, for example, eleven societies were in existence by 1823. The movement for the establishment of a national board of agriculture was renewed in 1817 by the Berkshire Agricultural Society of Massachusetts, which presented a memorial to Congress on this subject. The bill which resulted from this effort was, however, defeated in the House of Representatives. The following year (1818) saw the establishment of the New York Horticultural Society, the first organization of its kind in the United States. The American Farmer, the first distinctively agricultural periodical in this country, was started in Baltimore in 1819, and was very shortly followed by The Plough Boy, published by "Henry Homespun, jr.," at Albany, N. Y. The first agricultural paper in New England was issued in 1822.

Books on agriculture began to come more frequently from the press; among the most characteristic of these were "The Farmer's Assistant, by John Nicholson, esq., published at Albany, N. Y., in 1814 [a second large edition in 1820], embracing every article relating to agriculture, arranged in alphabetical order;" "Nugæ Georgicæ" (Agricultural Trifles), by the Hon. William Johnson, senior vice-president of the Literary and Philosophical Society of Charleston, S. C., published in 1815, which is an "endeavor to sketch the outlines of a picture of the cares and amusements, the duties and employments, of the Carolina farmer;" "Arator," by John Taylor, an eminent statesman and agriculturist, published at Petersburg, Va., in 1818, and considered the forerunner of the American Farmer, which seems to have had a great influence on Virginia agriculture; "The Farmers' Library," by Leonard E. Lathrop, published at Rochester, N. Y., 1826–1828, "to explain some of the fundamental principles which relate to agricultural science."

Gradually there came into being a desire for more exact and fresh information regarding agricultural conditions and needs, as is evidenced by the action of the State of Massachusetts in 1837 in authorizing an agricultural survey of the State to "collect accurate information of the State and condition of its agriculture and every subject connected with it, point out the means of improvement, and make a detailed report thereof, with as much exactness as circumstances will admit."

Along with these general measures for the instruction of the farmer there went a series of efforts to develop agencies for direct school training in the science and practice of agriculture. In 1819 Simeon De Witt, surveyor-general of New York, published a pamphlet at Albany urging the foundation under State authority of "The Agricultural College of the State of New York," not so much "to give instruction to farmers as to make farmers from the other classes of society, which are stocked with such a superfluity of members that hordes of them must otherwise remain useless or worse than useless to the community." Two years later (1821) Robert Hallowell Gardiner, of Maine, obtained an annual grant of $1,000 from the State legislature to aid in maintaining an institution which was to give mechanics and farmers "such a scientific education as would enable them to become skilled in their professions." This institution was incorporated as the "Gardiner Lyceum;" a stone building was erected for its use, and students were first received January 1, 1823. Rev. Benjamin Hale, a former tutor in Bowdoin College and later (1827–1835) professor of chemistry in Dartmouth College, was the first president. The course of study at the lyceum was arranged for two years, and there were twenty students the first year. The courses may generally be described as a chemical and a mechanical one. There was a permanent professor of agriculture, a practical farm, and special short winter courses. The school kept up for many years, its numbers reaching at one time as high as fifty-three. It had a good library and collections. About the same time (1822) the agricultural society of Albemarle, Va., made an earnest but unsuccessful effort to raise funds for the establishment of a professorship of agriculture in the University of Virginia. Prominent in this movement was James Madison, then president of the society, and the following extract from the letter written over his signature to the other agricultural societies of the State is interesting as showing the interest manifested in chemistry as an aid to agriculture:

> This science is every day penetrating some of the hidden laws of nature and tracing the useful purposes to which they may be made subservient. Agriculture is a field on which it has already begun to shed its rays, and on which it promises to do much toward unveiling the processes of nature to which the principles of agriculture are related. The professional lectures on chemistry, which are to embrace those principles, could not fail to be auxiliary to a professorship having lessons on agriculture for its essential charge.

In 1825 a plan for an agricultural college was submitted to the legislature of Massachusetts and discussed there and in the New England Farmer and other papers for some time. It was to be much like other colleges of the time, with the addition of courses in agriculture and mechanic arts, provided with a farm and shops. No immediate results followed this agitation. An agricultural school established at Derby, Conn., in 1826, proved immediately successful, and was obliged to increase its accommodations for students. Another phase of this movement is seen in the "manual-labor" schools organized in a number of places in New York between 1825 and 1840. They were founded for the purpose of enabling needy students to secure an education by devoting a part of their time to actual labor in the fields or shops, which should also constitute a part of their education. Though somewhat enthusiastically undertaken, this plan soon proved a total failure. The same idea has, however, been revived from time to time by those who are not aware of the teachings of experience in this direction.

Agitation on behalf of agricultural education grew more active, and between 1845 and 1850 a number of agricultural schools were established by private enterprise in New York and Connecticut, some of which met with considerable success for quite a period. In 1846 John P. Norton was appointed professor of agricultural chemistry and vegetable and animal physiology at Yale College, and the demand for teachers of agricultural chemistry had grown to be sufficient by 1848 to warrant the establishment of a course for their preparation at the same institution. In 1853 the New York legislature passed acts establishing a State agricultural college and an industrial school, to be known as "The People's College." These institutions, however, did not become firmly established. Agricultural colleges which have grown to be permanent and strong institutions were opened for students in Michigan in 1857 and in Pennsylvania and Maryland in 1859.

State agricultural colleges were incorporated in Iowa and Minnesota in 1858, and professorships of agriculture were established about this time in several literary colleges.

During the twenty years preceding 1860 the movement for the advancement of agriculture was greatly broadened and strengthened by organizations representing the different States. By the end of this period State agricultural or horticultural societies had been formed in Massachusetts, Connecticut, New York, Pennsylvania, Georgia, Ohio, Illinois, Michigan, Wisconsin, and Indiana, and State boards of agriculture in Indiana, Massachusetts, and Maine.

ORGANIZATION OF A NATIONAL AGRICULTURAL SOCIETY.

In 1841 an attempt was made to organize a national agricultural society at Washington and to secure the fund left by Hugh Smithson for the maintenance of such an organization, but this resulted in failure, owing to the decision to use this fund for the establishment of the Smithsonian Institution. But eleven years later (1852), at a convention called by twelve State agricultural associations, the United States Agricultural Society was organized. Professor Babson thus writes of the work of this society:

> The annual meetings practically accomplished the results which would have been obtained by a national board of agriculture, as suggested by General Washington and subsequently by the Berkshire Society in Massachusetts. The meetings were prolific of important reports, investigations, and, best of all, discussions. Association and communication of thoughts and interests were the secrets of its

great work, and up to the beginning of the civil war it was essentially the center of the agricultural interests of the country. At each of its meetings it urged the establishment of a Department of Agriculture, until finally the result was attained. It published a record of its transactions and also a periodical with "reports of the annual meetings, exhibitions, and operations of the society, with a general statement of the position of agricultural affairs at the metropolis and reports of the operations of State boards and societies and agricultural colleges and of all legislative recognition of the predominant interests of the country.

ORIGIN OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

Congress first took an active interest in the promotion of agriculture in 1839, when, on the recommendation of Hon. Henry L. Ellsworth, Commissioner of Patents, an appropriation of $1,000 was made for the "collection of agricultural statistics, investigation for promoting agricultural and rural economy, and the procurement of cuttings and seeds for gratuitous distribution among the farmers." This work was gradually developed; investigations in entomology, chemistry, and botany were provided for by 1855, and the way was thus opened for the establishment of the United States Department of Agriculture in 1862. It is sufficient to call attention here to the fact that the Department has taken an active part in movements for the technical education of farmers, and has directly disseminated a very large amount of useful information on agricultural subjects, much of which has been obtained through its own investigations and scientific researches.[1]

DEVELOPMENT OF SCIENTIFIC AND TECHNICAL EDUCATION.

In the foregoing brief outline of the main facts attending the development of the movement for the dissemination of agricultural information and the organization of institutions for agricultural education in this country during the first half of the nineteenth century, it has been shown that there was a gradual broadening and deepening of the public demand for national and State action in this direction. This movement on behalf of agriculture was, however, only one phase of a general intellectual and industrial advance, which widely affected public sentiment in the United States, as well as in the rest of the civilized world. The physical sciences, especially chemistry and geology, were developed with remarkable rapidity during this period and were revolutionizing some of the arts and producing great changes in agriculture. The development of steam transportation, the invention of the telegraph, the multiplication of machinery, the discovery of gold in California, the emigration of European people to this country, and the rapid spread of population west of the Alleghenies, all these things, scientific, industrial, and political, had brought about a general recognition of the fact that the old order of

[1] The work of the Department of Agriculture is fairly presented in the various papers in this Yearbook, each one of which discusses some phase of scientific or economic investigation in relation to agriculture in which the Department has taken part.—Ed.

things was passing away and awakened a great desire for new information and new training. The sciences found their way into the curricula of academies and colleges, slowly at first, but with accelerated rapidity as the years passed and competent teachers increased in number. The friends of the old classical education were, however, powerful enough to make progress in this direction altogether too slow to satisfy those who had enthusiastically adopted new views of education, and prevented anything like a symmetrical reorganization of courses of study so as to fully recognize the claims of the natural sciences to be a component part of the system of higher education. Moreover, institutions founded on literary and philosophical lines were not able to bring themselves at that period to favor the introduction of courses of instruction based on the needs of the students desiring to perfect themselves in the technical principles and practice of the arts and industries. Thus arose a demand for a new class of institutions which should be entirely devoted to scientific and technical education.

Some efforts were made to supply this demand by private enterprise, but the people, who by this time had become accustomed to the support of public schools for elementary education, quickly saw the advantage which would flow from the organization and maintenance of these new institutions under State or national patronage, and readily seconded the efforts of their leaders to secure recognition for the movement in State legislatures and in Congress. In their enthusiasm for the direct application of science to the arts, the people and educators alike oftentimes attempted to found agricultural and other technical schools on too narrow a basis, making them manual-labor or trade schools in which the fundamental principles of sound pedagogy were almost entirely neglected. There were, therefore, many failures and much confusion of thought as to the best curricula for scientific and technical schools. It was, in fact, too early in the history of the "new education" to expect clear definition of aim and purpose or the perfection of details of instruction. There must necessarily be many experiments and numerous failures before a system of technical education suited to the complex needs of modern industries and the American continent and people could be even fairly well formulated.

THE MORRILL ACT OF 1862.

It was fortunate that at this juncture the national leader who sought to crystallize the growing demand of the people for technical education into an act of Congress, endowing colleges for this purpose in every State of the Union, was a man of broad views and large practical sense, willing to draw his measure on comprehensive lines and leave future experience to work out successful results, even through many tribulations and great risk of fatal bungling. This man was Justin L. Morrill, of Vermont, who, having by his own efforts risen to success in mercantile and agricultural pursuits in the midst of a hard-working but intelligent and progressive community, had come to Congress in the prime of life with an open mind toward every measure which promised to widen the opportunities and increase the welfare of the masses and had in it the promise of attaining practical results by businesslike methods.

On December 14, 1857, Mr. Morrill introduced into the House of Representatives a bill "donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and mechanic arts," and granting 2,000 acres of land for each Member of Congress for this purpose. The bill was referred to the Committee on Public Lands, who brought in an adverse report April 15, 1858. Nevertheless, in the next session of Congress the bill passed both Houses, but was vetoed by President Buchanan. In spite of this defeat and the legislative disturbances caused by the opening of the great civil war, Mr. Morrill persisted in his efforts to secure national aid for industrial education, and on December 16, 1861, introduced an amended bill. A similar measure was introduced in the Senate May 2, 1862, by Benjamin Wade, of Ohio. On May 28 the bill was reported adversely in the House by the Committee on Public Lands, but was passed by the Senate June 10, and nine days later by the House. President Lincoln approved the bill July 2, 1862.

The provisions of the Morrill Act.

As finally passed the Morrill Act of 1862 was a comprehensive measure, providing for "the endowment, support, and maintenance of at least one college [in each State] where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life." For these purposes there was granted to the several States 30,000 acres of public land for each Senator and Representative in Congress, the entire proceeds of the sale of which must be so invested as to constitute a perpetual fund yielding not less than 5 per cent interest, "the capital of which shall remain forever undiminished (except so far as may be provided in section 5 of this act) and the interest of which shall be inviolably appropriated by each State which may take and claim the benefit of this act." The exception to this requirement is "that a sum, not exceeding 10 per cent upon the amount received by any State under the provisions of this act, may be expended for the purchase of lands for sites or experimental farms." "No portion of said fund, nor the interest thereon, shall be applied, directly or indirectly, under any pretense whatever, to the purchase, erection, preservation, or repair of any building or buildings." The colleges were to be entirely under the control of the States, and in fact could not be established or maintained unless the States provided buildings. It is obvious, therefore, that in this, as in other acts passed by Congress to aid the institutions, the national funds were intended to be only partial endowments, which were to be supplemented by the States in any way and to any extent required by their growing necessities.

Land donated and number of institutions benefited under the Morrill Act.

The amount of land actually obtained under this act ranged from 24,000 acres for Alabama to 990,000 acres for New York. Unwise management in many States caused the premature sales of the lands at a period when large grants to railroads and the opening of vast areas to settlers free of cost had made the college-land scrip almost worthless. The general result was that many States received small advantage from the land grant, the income of which in some cases was not sufficient to properly maintain even a single department of a college. In a few States, like New York and Michigan, where the number of acres received was large and the sale of the land was skillfully made, large funds were obtained and strong institutions were established. The total fund received from this land amounts to over $10,000,000, and 1,240,000 acres still remain to be sold.

Twenty-five years after the passage of the land-grant act of 1862 the United States Bureau of Education reported that forty-eight institutions had shared in the benefits of the act.

> In thirteen States the grant was made over to universities or colleges already existing, and has served to establish or augment the funds of courses, departments, or schools of applied science in the same. In the twenty-five remaining States the fund has served as the chief source of endowment for new institutions, or as the nucleus around which have collected additional funds, in several cases far exceeding the amount received from the national grant.

Early relations of institutions benefited by the Morrill Act to agricultural education.

In discussing the early relations to agricultural education of the institutions which received the benefit of the Morrill Act, it is difficult to make any general statements which will not be misleading. The broad provisions of the act; the widely varying amounts of money obtained from the sales of the land; the vagueness and incompleteness of the system of scientific and technical education in all lines, and especially in agriculture; the indifference of the farmers to agricultural education and their demand for the training of their children in other directions; the conservatism of the public and of educators regarding changes in long-established courses of study; the claims of established institutions to share in the benefits of this act; the no less urgent claims of the promoters of new colleges; the local, political, and denominational influences; the industrial conditions in this country—these are some of the factors which contributed to produce the greatest variety in the institutions organized under this act and to vary in still larger measure the attention which they gave to education in agriculture. While it is true that the sciences had begun to make their way into schools and colleges in this country prior to 1862, it is also the fact that for the most part the American colleges were institutions maintaining a single classical course, which must be rigidly followed by all students desiring to graduate. Courses of study in the sciences were yet to be developed, teachers in these branches were to be trained, and the system of elective studies was to be organized, while graduate courses of instruction and research were hardly thought of. Technical and industrial education necessarily had to wait until instruction in the sciences, on which such training must be based, had been put on something like a sound basis and had secured a reasonable supply of well-trained teachers and at least fairly adequate buildings, apparatus, text-books, and other equipment.

Even in the strongest institutions established under the Morrill Act of 1862, for many years most of the State and national funds obtained for their maintenance were wisely expended in building up sound education in the natural sciences. In this way only could they lay strong and deep foundations on which to rest a substantial superstructure of technical education when the times were ripe for its erection. Speaking broadly, the chief function of the land-grant institutions during the first quarter century of their existence was to aid in the establishment and perfecting of instruction in the natural sciences throughout the country. In doing this they did a great work for agriculture and the other industries by giving free tuition to thousands of students drawn from the industrial classes, who have since used their trained talents for the development of our industries by utilizing scientific facts and principles for their advancement. But more than this, these colleges at once begun, in greater or less degree, the building up of technical courses in agriculture and the development of agricultural research along scientific lines. If the farmers had responded to the efforts of the colleges in this direction many more of their children might have received direct, even if imperfect, instruction in the theory and practice of agriculture, and the movement for the development of such instruction might have been greatly accelerated. Amid many discouragements within and without, the colleges for technical education in agriculture gradually made their way, and the various lines of endeavor now hopefully expanding had their foundations surely laid in the institutions established under the Morrill Act of 1862. A new and peculiarly American principle had been introduced into our educational system by this great act, which is well set forth in the memorial address of President Buckham, of the University of Vermont, on Senator Morrill before the Association of American Agricultural Colleges and Experiment Stations at San Francisco, July 6, 1899, in the following words:

What Mr. Morrill meant, as his many speeches show, was that the liberal education of the industrial classes should make their pursuits professions, and should liberalize the industries and arts of life. This is really the central and controlling thought of the whole scheme—to bring the light of learning and the aid of science to bear upon those pursuits and callings which, hitherto regarded as illiberal and wearing the badge of inferiority, would thus be lifted to the plane with the other professions, and confer equal respectability upon their members.

DEVELOPMENT OF FARMERS' INSTITUTES.

Meetings which the general public and especially farmers were invited to attend were held at a comparatively early day under the auspices of the local or State agricultural societies. Out of these meetings grew a more or less clearly defined institution for the technical education of the adult farmer, now known as the farmers' institute. While the character of the institutes is such as to make it impracticable to assign any definite date as the time of differentiation from other farmers' assemblies, yet the period following the organization of the agricultural colleges under the Morrill Act of 1862 seems to have been the time when the farmers' institutes took a distinct form, and under that name began to receive the patronage of the States. Thus, in 1862 the Massachusetts State Board of Agriculture held a public meeting of four days' duration, and in 1866 the Connecticut State Board of Agriculture held its first farmers' convention for lectures and discussion. In 1870 the newly organized State Board of Agriculture of New Hampshire began a series of farmers' meetings, and the following year Vermont followed this example. The same year the Massachusetts board requested the twenty-nine agricultural societies of the State to organize annual meetings, to be denominated the "Farmers' Institutes of Massachusetts," and several societies began at once to hold such meetings. About the same time institutes were inaugurated in Kansas, and a little later in Michigan, by the agricultural colleges of these States. Other States joined the movement, and legislatures began to make appropriations to maintain the institutes.

In 1885, when the board of regents of the University of Wisconsin organized a course of institutes, a special officer, called the superintendent of farmers' institutes, was appointed to plan and manage them, and this arrangement was afterwards confirmed by the State. While the institutes are carried on under varied auspices in the different sections of the country, the character of the meetings themselves has been essentially the same wherever they have been held. They are usually held during the winter months, but in some cases at other seasons of the year, and as a rule continue from two to four days. "The programmes are planned to promote the interchange of ideas, a full and free discussion being sought upon topics introduced in an address or paper by some specialist." Officers of agricultural colleges and experiment stations, and other experts, together with successful farmers who have attained more than local reputations, are usually selected as institute workers by the officers who have charge of the system of institutes for the State, or they may be chosen by the local authorities from lists prepared by the central bureau. There is very often a local committee, which provides local speakers, music, literary, and other general exercises, and arranges for the place of meeting, refreshments, and advertising.

All persons in attendance, the humblest as well as the most prominent, are urged to ask questions upon points suggested in the address and to present related facts gained from personal experience. A "question box" is frequently made use of, answers being given by the conductor of the institute or by some one specially fitted to supply the information asked. For the evening sessions the usual plan is to have a popular lecture upon some subject of general agricultural interest. This address is made somewhat more elaborate and complete than those of the day sessions and less opportunity is given for discussions.

ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

The need of coming together for conference was definitely recognized by the institutions organized under the Morrill Act of 1862 as early as 1883, when a convention of delegates from the agricultural colleges met at Washington, D. C., for the special purpose of promoting the establishment of experiment stations in connection with these colleges. On July 8, 1885, a convention of agricultural colleges and experiment stations (a number of which had by this time been organized by the States as separate institutions) met at the Department of Agriculture in Washington in response to a call issued by the then Commissioner of Agriculture, Norman J. Colman, of Missouri, and on October 18, 1887, at a second convention in the same city a permanent organization was effected, under the name of "The Association of American Agricultural Colleges and Experiment Stations." This association was at first very largely interested in the establishment and development of the agricultural experiment stations, but from the outset gave considerable attention to the general interests of the land-grant colleges, and from time to time has made this feature of its work more prominent. The work of the association is, in fact, much broader than its name would indicate. The institutions comprising it cover a very wide range of educational work, several of them being great universities, numbering their students by the thousand and their instructors and courses of study by the hundred. The association has, however, always been active and earnest in its efforts to promote agricultural education, and has been an influential factor in aiding the advancement of such education throughout the country.

THE AGRICULTURAL EXPERIMENT STATIONS.

Even before the passage of the Morrill Act of 1862 the agricultural schools and colleges established under private or State auspices began experimental inquiries on agricultural problems, and the institutions which received the benefits of that act took up the same work in a larger way. In 1875 a regularly organized experiment station was established by the State of Connecticut. Other States followed this example by establishing experiment stations either as separate institutions or in connection with the land-grant colleges. In 1887 Congress nationalized this movement by the passage of the Hatch Act, which provided for the establishment and maintenance of experiment stations as departments of the land-grant colleges in all the States and Territories. These institutions are in law and in fact integral parts of the higher institutions for education in agriculture, representing essentially the university side of such education, being set above the undergraduate departments of the colleges as organizations devoted to original research.[1] They are the fountain heads of agricultural knowledge, and the results of their work are more and more to form the basis of all instruction in agricultural science from the college down to the common school and out to the masses of workers on our farms. Already they have surpassed all other agencies in the dissemination of useful information among our farmers and have collected a fund of new knowledge which has radically changed the text-books and courses of instruction in agriculture in this country.

THE SECOND MORRILL ACT.

The establishment of the experiment stations greatly quickened the interest in agricultural education throughout the country. The demand for other forms of technical education had also grown apace. It became evident that the land-grant institutions in many States were unable to meet the calls made upon them to increase their faculties and facilities for technical education. There was increasing liberality on the part of the States toward these institutions, but the State appropriations were in many cases very inadequate. At this juncture Mr. Morrill came forward with a proposition to increase the endowment of the land-grant colleges out of the national funds arising from the sale of public lands. His bill for this purpose passed both Houses of Congress and was approved by President Harrison August 30, 1890. This act provides for an annual appropriation, as follows:

> To each State and Territory for the more complete endowment and maintenance of colleges for the benefit of agriculture and the mechanic arts now established, or which may be hereafter established, in accordance with an act of Congress approved July second, eighteen hundred and sixty-two, the sum of fifteen thousand dollars for the year ending June thirtieth, eighteen hundred and ninety, and an annual increase of the amount of such appropriation thereafter for ten years by an additional sum of one thousand dollars over the preceding year, and the annual amount to be paid thereafter to each State and Territory shall be twenty-five thousand dollars, to be applied only to instruction in agriculture, the mechanic arts, the English language, and the various branches of mathematical, physical, natural, and economic science, with special reference to their applications in the industries of life, and to the facilities for such instruction.

[1] The history of experiment stations is given in a separate article in this Yearbook.—Ed.

Provision is made for separate institutions for white and colored students in States which may desire to make such an arrangement. The Secretary of the Interior is charged with the administration of the law, and is given authority to withhold the appropriation to any State or Territory for cause, subject to an appeal to Congress.

DEVELOPMENT OF COLLEGES OF AGRICULTURE DURING THE CLOSING DECADE OF THE CENTURY.

The second Morrill Act has been of great benefit to agricultural education in this country. Many of the land-grant colleges which formerly had done little for their agricultural courses, either because of their limited funds or through lack of interest in the subject, were enabled to put them on a respectable footing, and were aroused to renewed efforts to make them substantial and attractive. The State legislatures were also more easily led to make liberal appropriations for buildings and facilities for instruction in these institutions, now that their value and importance had been recognized in such a notable manner by Congress. The friends of agricultural education became more active in urging their claims upon faculties, boards of management, and legislatures, and met with increasing success in securing for agriculture a larger recognition in the college curriculum. The establishment of the experiment stations had attached to these colleges a much larger and stronger body of men whose prime interest was on the side of agriculture, and the increased financial revenues of the colleges made it possible to utilize the services of many more instructors in agricultural subjects. The ten years which have elapsed since the passage of the second Morrill Act have therefore been marked by the development of agricultural education along a number of new lines. They have been in great measure years of preparation, the result of which will be realized in the coming century. Many plans for advancement in agricultural education have been proposed, and many tentative propositions for the improvement of the working scheme for such education have been suggested. Here and there new enterprises in this direction have been very successful; and what is perhaps the most important thing, there has been a growing hopefulness that before long there will be such a system of education in agriculture in this country as will not only supply a sufficient number of well-trained leaders in agricultural progress, but will also spread abroad among the masses of our rural population definite and useful information regarding the principles and the best practice of agriculture.

The rapid advance in the number and extent of scientific investigations along agricultural lines has revealed to scientists, schoolmen, and farmers alike something of the breadth and depth of the subject of agriculture, whether considered as a science or as an art. This has led to a recognition of the fact that no single scheme of technical education in agriculture will meet the needs of our times. Two general results of vital importance have followed: First, the subject of agriculture has been divided into an increasing number of specialties, and each year more men have devoted themselves to the study and teaching of some one branch of agriculture; and, second, instead of being satisfied with maintaining one general curriculum in agriculture, covering the usual period of four years, the colleges have more and more endeavored to diversify the courses in agriculture and adapt them to the needs of different classes of students. Agriculture, considered as a subject of education, has felt the same influences which in other subjects have produced such wide specialization and such varied courses of instruction. The movement, as related to agriculture, has not, however, proceeded so far as in the case of other subjects, and the century will close without witnessing the thorough organization of agricultural education in this country along permanent lines.

In the older curriculum the teaching of agriculture was for the most part divided between the agricultural chemist, who dealt especially with matters relating to soils, fertilizers, and the principles of feeding and dairying, and the so-called agriculturist, who usually was expected to cover the round of farm practice. Instruction regarding the diseases of animals was at an early day given a distinct place under the name of veterinary science. The diseases of plants were turned over to the botanist or horticulturist, and insect pests to the zoologist or entomologist. In most institutions horticulture was clearly divided from agriculture. The new movement for the division of the general subject of agriculture in the colleges of this country may perhaps be said to have begun with the separation of dairying as a distinct branch of instruction. This was in large measure due to the revolution in the methods of dairying, caused by the investigations of the experiment stations, which led to the multiplication of creameries and cheese factories. The technology of dairying on both its scientific and practical sides became a large and distinct subject in the minds of the farmers and the college authorities. This made it easy to assign dairying a separate place in the curriculum, and to provide one or more special teachers for this branch of agriculture. The science of animal production (zootechny) about this time assumed large proportions, and as means increased it was found desirable to have at least one teacher in the college faculty who should devote himself exclusively to this subject. But this has already proved too large a burden for any one man to carry to the complete satisfaction of his students, and a few of our strongest colleges have subdivided this subject. More recently studies in agricultural physics, especially as related to soils, have been so far developed and systematized that special laboratories and teachers for this branch of agriculture have been found very desirable wherever the resources of the institution would permit. By the changes above indicated a place has been made for the more systematic organization of instruction in plant production (agronomy) as a distinct college department, and this has been done at a number of colleges. Thus far rural engineering and rural economics, including the history of agriculture, have been incidental features of our college courses, and have been assigned to teachers whose main work has been in other lines.

The specialization of work and the consequent increase in number of instructors have made it possible to more efficiently organize various forms of short and special courses in agricultural subjects. As long as the four years' course in agriculture was a simple and rigid curriculum, the attempt to introduce a shorter course on the same general plan, but more superficial and imperfect in detail, did not prove generally successful. It was difficult for the outside public to distinguish between the two courses, which led the long-course students to think that their standing as college men was imperiled by misunderstanding regarding their status as compared with that of the short-course students. While the pedagogical character of the long course was as a rule nondescript, that of the short course was still more so. So general was the dissatisfaction with these earlier short courses that at one time it seemed as if the colleges would wholly abandon them; but now they are being revived in new and much more satisfactory forms. When the short course covers the general subject of agriculture, a better selection of topics is made and the student receives from different specialists more definite information and a more intense stimulus to pursue the subjects further on his own account. But the greatest success has been attained with the short courses which have included only a limited number of agricultural topics and afforded more precise and extended practical instruction along one or two lines. This has been particularly true of the short courses in dairying, in which it has been found practicable to unite with the theoretic instruction sufficient practice to enable the student taking such a course to become an efficient worker in the farm dairy or the creamery or cheese factory. The diversification of the four years' course in agriculture, through the introduction of the elective system, and the elevation of this course to a grade more nearly approximating other courses for which the bachelor's degree is given, have in large measure done away with the student's opposition to the obviously lower courses occupying a shorter time. The present tendency is toward the organization of the shorter courses as schools distinct from the college departments, though belonging to the same institution. These may be special schools, as in dairying, or general agricultural schools of secondary grade.

THE IMPROVEMENT OF COLLEGE COURSES IN AGRICULTURE.

Courses in agriculture in our colleges have developed very largely according to the views of individual teachers or the supposed or real necessities of the institutions, owing to their local environment; but with the establishment of courses in the natural sciences on a sounder pedagogical basis and the rapid enlargement of the courses for instruction in the theory and practice of agriculture, there has been increasing realization of the desirability of systematizing courses in agriculture according to modern pedagogical methods.

Realizing this need, the Association of American Agricultural Colleges and Experiment Stations, at its convention in 1894, appointed a committee on entrance requirements, courses of study, and degrees, whose final report, presented two years later, was adopted. This report recommended as a standard series of entrance requirements for college courses the following subjects: (1) Physical geography; (2) United States history; (3) arithmetic, including the metric system; (4) algebra to quadratics; (5) English grammar and composition, together with the English requirements of the New England Association of Colleges and Preparatory Schools; (6) ancient, general, or English history. Recognizing the fact that a considerable number of the land-grant colleges were not in a position to immediately insist on these entrance requirements, the committee suggested that all should unite in requiring the first five subjects as a minimum for admission to their lowest collegiate class. For all four years' courses, leading to a bachelor's degree, it was urged that the colleges should require the following general studies: (1) Mathematics, at least through algebra, geometry, and trigonometry; (2) physics and chemistry, with laboratory work in each; (3) English language and literature; (4) other languages (one at least modern); (5) mental science and logic or moral science; (6) constitutional law; (7) social, political, or economic science.

In 1895 the association appointed a standing committee on methods of teaching agriculture, which has thus far presented four reports of progress. Taking up the work where the committee on entrance requirements left it, this committee first suggested that the following subjects be added to the general subjects named above to complete the four years' course in agriculture leading to the degree of bachelor of science: (1) Agriculture; (2) horticulture and forestry; (3) veterinary science, including anatomy; (4) agricultural chemistry; (5) botany, including vegetable physiology and pathology; (6) zoology, including entomology; (7) physiology; (8) geology; (9) meteorology; and, (10) drawing. It then proceeded to divide the subject of agriculture as follows: (1) Agronomy, or plant production; (2) zootechny, or animal industry; (3) agrotechny, or agricultural technology; (4) rural engineering, or farm mechanics; and, (5) rural economics, or farm management. It has since presented somewhat detailed outlines of courses in agronomy and zootechny. It is believed that the work of these committees is chiefly significant as indicative of an earnest and widespread movement among the colleges of agriculture to systematize and improve the courses in agriculture. The committees have simply endeavored to give form to a general desire for the elevation of college courses in agriculture to the same level as other college courses and the specialization of the instruction in agriculture as is being done everywhere in regard to other subjects included in the modern scheme of liberal education.

ORGANIZATION OF SECONDARY SCHOOLS OF AGRICULTURE.

The improvement of the college courses in agriculture has been accompanied by efforts to provide courses which are distinctly of secondary grade. It has become clear that the college courses will meet the needs of only a comparatively small number of students from the farms, and that a large part of the college graduates will find their most suitable employment as investigators, teachers, journalists, or workers in those industries more or less closely connected with agriculture in which knowledge of the science as well as the practice of agriculture is requisite. Instruction in agriculture of the secondary grade has for some years been given in connection with the other industrial courses at the Hampton Institute, in Virginia, and more recently at the Tuskegee Institute, in Alabama, and some other similar schools for colored students. In 1895 a secondary school of agriculture was organized at the University of Minnesota, with a course of study and faculty clearly differentiated from those of the college of agriculture. This school has been largely attended and has proved quite successful. For the past two years girls as well as boys have been admitted to this school, and special provision has been made for their residence at the institution. A similar school has recently been opened at the University of Nebraska. The State of Alabama has for a few years past made provision for the maintenance of schools of agriculture of secondary grade in each of the nine Congressional districts of the State. The Baron de Hirsch Agricultural and Industrial School, at Woodbine, N. J., regularly opened for students in 1894, provides general and agricultural education of the secondary grade, combined with a large amount of practical farming and horticulture, to a limited number of boys and girls. A similar school for boys is the National Farm School at Doylestown, Pa., opened for students in 1897.

EFFORTS TO INTRODUCE AGRICULTURE INTO THE COMMON SCHOOLS.

Throughout the century efforts have been made from time to time to introduce instruction in agriculture into the common schools. These efforts have uniformly failed, partly because too much was attempted, and partly because the condition of the schools did not permit of changes in their curriculum in this direction. Thus far our common schools, especially in the rural districts, have done very little toward introducing even elementary lessons on natural objects, and much less the systematic study of the elements of any natural science. The organization of anything like a complete system of common schools over vast areas of a new territory with a rapidly growing population has been a gigantic task, and until recently there has been little opportunity for the consideration of measures for the improvement of courses of instruction in our rural schools. We have been justly proud of the wide and free dissemination of elementary education in this country, but we have hardly yet come to realize how much needs to be done to put these schools on the most efficient basis. For some years it has been apparent to close students of the rural schools that the most practicable step toward the introduction of instruction which would directly bear on agriculture was to secure some definite training of the pupil's powers of observation through exercises based on natural objects. A very hopeful beginning of a movement in this direction, which now promises to become widespread, was made in 1894 in connection with the College of Agriculture of Cornell University, under the leadership of Prof. L. H. Bailey.

By visiting the rural schools and giving sample lessons, the officers in charge of this work ascertained the needs and requirements of these schools as regards nature study and secured the interest and cooperation of a considerable number of school officers and teachers in a comparatively short time. To show the teachers more definitely how nature study may be presented to their pupils, a series of leaflets was begun, which were distributed throughout the State wherever teachers showed an interest in the movement. The plan proved at once successful, and means for its extension have been increased by succeeding legislatures. A corps of instructors have been employed in canvassing the State, and these have been aided by special teachers from time to time as occasion requires. These instructors meet the teachers of the schools in the presence of their pupils and at teachers' meetings for the purpose of illustrating methods for teaching nature studies. The leaflets serve as texts for the subjects taught. Very naturally, many of these leaflets are on subjects directly relating to agriculture, such as cultivated plants, fruits, weeds, and insects. It has been impracticable, even if it were at all desirable, to confine this movement to the rural schools, for the city teachers, who had in many cases begun nature teaching in one form or another, have been very eager to receive and utilize the leaflets and other special instruction on nature teaching emanating from Cornell University. It is reported that 25,000 teachers in New York State alone have received some instruction in this way, and the leaflets, being sold, are widely disseminated in other States. Some of the other colleges of agriculture, notably in Indiana, Missouri, Rhode Island, and Pennsylvania, are taking up this work, and plans for the introduction or more effective use of nature study in the common schools are being made in a number of States.

DEVELOPMENT OF UNIVERSITY EXTENSION IN AGRICULTURE.

Other forms of university-extension work in agriculture are being actively pushed by the agricultural colleges. Allusion has already been made to the work of these institutions in connection with the farmers' institutes. This work has been greatly developed since the establishment of the experiment stations. In one sense the immense amount of literature on agricultural subjects disseminated by the experiment stations and this Department form the most important and successful university-extension work thus far carried on in this country.

FEATURES OF THE EXTENSION WORK.

An interesting feature of this movement was inaugurated in a definite way by the State College of Pennsylvania in 1892, under the title "Chautauqua course of home reading in agriculture." The college provided a list of books and offered examinations on the subjects read. It was soon found desirable to help the readers over difficulties by correspondence. When the lack of suitable books for such a course became apparent, the college undertook to send out printed lessons and questions on particular subjects treated in the books, which should guide the readers to an intelligent use of the books, bring out their important points, and extend and illustrate the information which they contained. This plan proved highly successful, and the number of subjects on which lessons were thus prepared was extended until during the past year five courses, each comprising seven subjects, or books, were offered. On March 1, 1899, there were 3,416 readers enrolled, of whom 460 received systematic instruction by means of the lessons. There were readers in most of the States and some in foreign countries. This work of the college has outgrown the resources which can be devoted to its maintenance, and of late no special effort has been made to increase the enrollment. Farmers' reading courses have since been undertaken in various forms by the agricultural colleges in Michigan, New Hampshire, Connecticut, West Virginia, South Dakota, and New York.

In New York the reading courses form part of a more elaborate scheme of university extension than exists elsewhere in this country, one feature of which is the nature teaching already referred to. Here the course began with horticulture, but has been extended to include general agriculture. In its present form the New York plan is to send the farmer short, specially prepared lessons, with questions on a few topics, and to organize reading clubs; these clubs are visited by lecturers and inspectors, who give information and help to keep up the organization and enthusiasm. Last year 8,600 readers were enrolled, of whom over 8,000 were residents of New York. Another feature of the New York university-extension work is the itinerant school, in which special topics in horticulture or agriculture are taught for a few days by experts, thus imparting more definite and extended information than is possible in the single lectures at farmers' institutes.

Cooperative experiments, in which farmers in different localities have participated, have been made in Connecticut and other States almost from the beginning of the experiment-station enterprise. More attention is now being given to perfecting the plans and records of these experiments, and it is quite generally recognized that they are chiefly valuable as educational agencies. In New York this work has been joined with the general plan for university extension, in charge of the college of agriculture of Cornell University, and liberal appropriations have made it possible to carry on hundreds of simple experiments throughout the State.

Now that the educational world has become fairly awake to the comprehensive mission of the teacher, it sees that the set institutions of learning are not simply to do what they can for the youth who happen to come within their halls, but that they are rather to be the centers of light and inspiration to all the community about them. It is their business to go out and instruct men wherever they can find them, as well as to offer any proper inducement for pupils to come into their class rooms, because there can be found what is suited to their varied needs as regards both culture of body and mind and training for the life's work. Standards of acquirement there must be, and these have been made more thorough and exacting. Instruction must conform to sound pedagogical principles, and more attention is being devoted to studies of the mind of the pupil as related to his acquisition of knowledge. To do his best work the teacher must have aptitude and general and special training beyond what has hitherto been thought necessary. But after all the school must take the pupil where it can find him and do for him the best it can, considering chiefly his status and environment. It is the recognition of this fundamental principle, partial though the recognition has been thus far, which is producing the most profound change in the work and spirit of our institutions for education in agriculture, as it is also in other educational institutions everywhere.

AMERICAN BOOKS ON THE SCIENCE AND PRACTICE OF AGRICULTURE.

For many years one of the serious hindrances to the success of education in agriculture in the schools or among the farmers was the lack of good books on agriculture setting forth the facts and principles of agricultural science and practice as related to conditions of farming in the United States; but since the establishment of the experiment stations, and especially within the past few years, there has been a great increase in the number of books which are useful for the education of our agricultural people along the lines of their art. Much attention is being given to the preparation of books which may serve as works of reference or as text-books in different grades of agricultural instruction. The publications of the stations and of the Department in large measure supply the materials for these books, and they are written from an American standpoint. There is already a healthful competition in the production of books best adapted to special purposes of agricultural education, and thus the way is being prepared for the more general and satisfactory diffusion of such education in the twentieth century.

DEVELOPMENT OF GENERAL AGENCIES FOR THE EDUCATION OF FARMERS.

The second half of the nineteenth century has witnessed a great awakening of the farmers of this country to their educational needs and opportunities. This has led to the broadening of the work and influence of general agencies for their education. The State and local societies have been supplemented by great national organizations, such as the Farmers' Alliance and the Patrons of Husbandry (granges), which, besides doing a great deal for the promotion of their general welfare, have done much to quicken the desire of multitudes of farmers for definite education in matters relating to their art. That portion of the newspaper press which is wholly or partially agricultural has been more active and far-reaching than ever before in its efforts to disseminate useful information among the rural masses. State departments and other agencies for aiding the farmer to acquire knowledge along agricultural lines have been greatly strengthened. The limits of this article will forbid anything more than the mere mention of the origin and usefulness of these general agencies for agricultural education. In considering in any broad way the institutions for the farmers' education which now exist in this country, great credit must be given to those organizations which, though established for more general purposes, have exerted their influence to arouse the farmer to see the need of progress and enlightenment, and which have labored earnestly for the establishment and maintenance of institutions definitely organized for technical education in agriculture. Without the movement for the farmers' uplifting, begun and fostered by those general agencies, the schools and colleges of agriculture could not have reached their present promising condition.

THE AMERICAN SYSTEM FOR AGRICULTURAL EDUCATION IN THE YEAR 1900.

Without taking into account the general educational agencies just referred to, the American system for agricultural education as it exists at the close of the nineteenth century comprises a number of important branches whose functions may be more or less clearly differentiated.

DEPARTMENTS OF ORIGINAL RESEARCH AND GRADUATE STUDY IN AGRICULTURE.

At the head of this system stand the Department of Agriculture and the agricultural experiment stations now in operation in all the States and Territories chiefly as departments of the land-grant colleges. These constitute very largely the university, or graduate branch of agricultural education in this country, having for their chief functions the discovery and dissemination of new truths regarding the theory and practice of agriculture. Organized primarily with reference to research, both the Department and the stations to a considerable extent directly promote agricultural education, in the technical sense, by giving instruction to students. This is done by opening their laboratories to assistants who participate in research work while continuing their studies, or by imparting new inspiration and knowledge to students who become acquainted with the research work by indirect contact through residence at the institutions where it is being conducted. From time to time officers of the agricultural colleges and experiment stations come to work in the Department of Agriculture for a period, to carry on special investigations or to enlarge their knowledge of scientific facts and principles in special lines. In accordance with an arrangement recently made, a limited number of graduates of the land-grant colleges are admitted to the Department for advanced study and research. At the universities and colleges having courses in agriculture there are now a considerable number of persons pursuing graduate courses in agricultural subjects. This has for the most part been made possible by the establishment of the experiment stations as research departments of these institutions and the consequent employment of experts in different lines of agricultural science competent to give graduate instruction in their several specialties.

COLLEGE COURSES IN AGRICULTURE.

Under the provisions of the acts of Congress of July 2, 1862, and August 30, 1890 (Morrill acts), sixty-four colleges are in operation in the several States and Territories. Of these, about sixty institutions maintain courses in agriculture. In fourteen States separate institutions are maintained for white and colored students. These institutions are brought together to constitute a national system of higher education in the sciences and industries through the Association of American Agricultural Colleges and Experiment Stations, the Office of Experiment Stations of the Department of Agriculture, and the Bureau of Education of the Department of the Interior. The colleges of agriculture may be divided into three classes, according to the general differences in their organization: (1) Colleges having only courses in agriculture; (2) colleges having courses in agriculture along with those in a variety of subjects, including especially mechanic arts; and, (3) colleges (or schools or departments) of agriculture forming a part of universities. The only institution in this country which is simply an agricultural college is the Massachusetts Agricultural College.

Agricultural and mechanical colleges have been organized in Alabama, Colorado, Connecticut, Delaware, Florida, Iowa, Kansas, Kentucky, Maryland, Michigan, Mississippi, Montana, New Hampshire, New Jersey, New Mexico, North Carolina, North Dakota, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Texas, Utah, Virginia, and Washington. Separate institutions of this class for colored students are maintained under the Morrill Act of 1890 in Alabama, Delaware, Florida, Mississippi, North Carolina, South Carolina, and Virginia. The instruction in these institutions has, however, very wisely been confined for the most part to courses below the college grade. A similar institution, maintained by private funds, is the well-known Tuskegee Industrial Institute, in Alabama.

Colleges of agriculture (or equivalent schools or departments) in universities are maintained with the aid of national funds in Arizona, Arkansas, California, Georgia, Idaho, Illinois, Indiana, Louisiana, Maine, Minnesota, Missouri, Nebraska, Nevada, New York, Ohio, Tennessee, Vermont, West Virginia, Wisconsin, and Wyoming. In Massachusetts, Harvard University has a school of agriculture known as Bussey Institution.

The college course in agriculture in most of these institutions extends through four years and leads to a bachelor's degree. The course varies considerably in different institutions as regards the requirements, both for admission and for graduation. In some cases students are admitted directly from the common schools, while in others the entrance requirements are on a level with those for admission to other college courses in high-grade colleges. The course at the Massachusetts Agricultural College may be taken as a type of a relatively high-grade college course in agriculture as given in American colleges. Candidates for admission must be at least 16 years old, and are required to pass examinations in English grammar, geography, United States history, physiology, physical geography, arithmetic, the metric system, algebra (through quadratics), geometry (two books), and civil government. The student is required to follow a definitely prescribed curriculum during three years, and in the fourth and last year of the course he is allowed wide latitude of choice among numerous specialties, English and military science being the only required studies. In freshman year the following subjects are included in the course: Agriculture, botany, chemistry, algebra, geometry, bookkeeping, English, French, military tactics, and mechanical drawing; in sophomore year, agriculture, horticulture, botany, chemistry, anatomy and physiology, trigonometry, surveying, English, and mechanical drawing; in junior year, agriculture, horticulture, chemistry, zoology, entomology, physics, English (including rhetoric and literature); in senior year, together with the required English and military science, at least three elective studies must be taken, which may be selected from the following: Agriculture, botany, chemistry, entomology, veterinary science, civil engineering, analytical geometry, calculus, English, German, Latin, political economy, history, and farm law.

In these colleges, as a rule, ample provision is made for the teaching of the sciences related to agriculture. Horticulture, vegetable pathology, economic entomology, and veterinary science are commonly taught along with agriculture, but by separate instructors. An outline course in forestry is also often given. The subject of agriculture is not infrequently divided among two or more instructors. Matters relating to soils, fertilizers, and the composition of plants, dairy products, etc., are often taught under the head of agricultural chemistry. Agricultural physics, especially as relating to soils, has been recently made a separate department of instruction in a number of colleges. The theory and practice of dairying, animal husbandry, and plant production have, in some cases, each been assigned to different instructors. Here and there some branch of animal husbandry (as sheep raising) has been deemed sufficiently important to require a special teacher. In general, differentiation of subjects hitherto grouped together under the general term "agriculture" is more and more followed by the employment of specialists to teach in a limited field. Much greater attention is being given than formerly to the improvement of methods of teaching agricultural subjects. This is evidenced by the employment of more thoroughly trained teachers, by individual and associated efforts to define and arrange the topics of instruction in accordance with pedagogical principles, by the general adoption of the laboratory system as applied to the field, the plant house, and the barn, as well as to the buildings constructed with special reference to the peculiar needs of instruction in agricultural subjects.

The collection and devising of apparatus and illustrative material are being pushed with much enthusiasm and success. Wherever means will permit, and in an increasing number of institutions, the housing and equipment of the agricultural department will compare favorably with that of other departments. Along with the improvement of the college courses in agriculture has come the realization of the true function of these courses. It is now well understood that they are for the training of the leaders in agricultural progress and not for the general education of the agricultural masses. For this purpose they are to be made as thorough and complete internally and externally as the manifold needs of American agriculture for well-trained and intelligent leadership may require. Their success is to be judged by the same standard that is applied to other college courses, and the number of students is not of so much importance as their quality. For the general education of the agricultural people, young and old, other agencies than the four years' college course are to be employed, which will require for their management a large share of the graduates of the agricultural colleges.

Owing to the complicated organization of many of the institutions having courses in agriculture and the fact that the students in agricultural courses in many subjects are in classes with students in other courses, and that much of the equipment is used in common by the students in all the courses, it is impracticable to show by statistics, with exactness, the means and facilities for strictly agricultural education. The general statistics of the land-grant institutions may, however, serve to show with how great an enterprise, devoted chiefly to higher education along scientific and industrial lines, agriculture has been joined in permanent alliance, and to indicate in some measure how extensive are the educational facilities at the command of the youth of the country who have sufficient intelligence, courage, and perseverance to follow out long and thorough courses of study in agriculture.

The aggregate value of the permanent funds and equipment of the land-grant colleges and universities in 1898 is estimated to be as follows: Land-grant fund of 1862, $10,170,549.99; other land-grant funds, $1,204,234.44; other permanent funds, $11,816,258.16; land grant of 1862 still unsold, $3,838,219.48; farms and grounds owned by the institutions, $6,046,500.16; buildings, $15,185,476.95; apparatus, $1,916,227.85; machinery, $1,383,137.14; libraries, $1,634,190.25; miscellaneous equipment, $1,765,243.19—total, $53,632,852.25. The income of these institutions in 1898, exclusive of funds from the United States for agricultural experiment stations ($720,000), was as follows: Interest on land grant of 1862, $645,546.28; interest on other funds, $578,067.38; United States appropriation under act of 1890, $1,108,610.38; State appropriation (annual or regular), $1,827,924.51; State appropriation (occasional), $533,794.98; tuition fees, $480,847.32; incidental fees, $146,458.72; miscellaneous, $679,130.93—total, $6,008,379.20. The value of the additions to the permanent endowment and equipment of these institutions in 1898 is estimated as follows: Permanent endowment, $1,424,277.64; buildings, $851,481.75; library, $105,661.11; apparatus, $132,111.90; machinery, $123,477.63; miscellaneous, $167,336.53—total, $2,796,350.97. The number of persons in the faculties of the colleges of agriculture and mechanic arts were as follows: For preparatory classes, 254; for collegiate and special classes, 1,564—total, 1,722. In the other departments the faculties aggregated 889, making a grand total of 2,611 persons in the faculties of the land-grant institutions. The students in 1898 were as follows: (1) By classes: Preparatory, 6,593; freshmen, 6,016; sophomores, 4,202; juniors, 3,216; seniors, 2,506; special, 4,526; post graduate, 878—total, 31,658. (2) By courses: Agriculture, 4,181; mechanical engineering, 2,797; civil engineering, 1,504; electrical engineering, 1,698; mining engineering, 554; architecture, 411; household economy, 1,298; veterinary science, 449; military tactics, 8,952. The graduates in 1898 were 2,328, and since the organization of these institutions 34,168. The average age of graduates in 1898 was 22.1 years. The total number of volumes in the libraries was 1,221,226.

SHORT AND SPECIAL COURSES IN AGRICULTURE.

In many of the colleges of agriculture provision has been made for more elementary and practical education in agriculture by establishing short courses. These may continue through two college years or be limited to a few weeks, chiefly in the winter months. Recently, successful short courses have been given at a few colleges in the summer, when the regular college courses were suspended. The short courses may either cover agriculture in general or be confined to some special line, as dairying. Now that the short courses are quite clearly differentiated from the regular college courses in agriculture the objections formerly made to them are no longer strongly urged, and in popularity and success they seem to have entered on a prosperous career. The short courses offered by the University of Wisconsin may serve to illustrate the nature of this feature of the American system for agricultural education. "The short course in agriculture," it is stated, "is designed to meet the wants of young farmers who desire practical, helpful instruction in agriculture before taking up their chosen vocation. This course covers two terms of twelve weeks each, beginning the first of January each year." It includes lectures on feeds and feeding, breeds of live stock, agricultural chemistry, agricultural physics and meteorology, plant life, veterinary science, dairying, farm bookkeeping, horticulture, agricultural economics, and bacteriology. Laboratory practice is given in dairying, physics, plant life, stock judging, and horticulture, and practical work in carpentry and blacksmithing. The dairy course occupies one term, and includes theoretical and practical instruction in the science and practice of dairying and dairy farming. It is definitely planned to meet the needs of persons intending "to operate creameries and cheese factories," and has been very successful in training men competent for work of this kind. The students engage in milk testing, operate separators and butter extractors, and attend to the ripening of the cream, churning and packing butter, and all the operations of a creamery and cheese factory.

This dairy school has already sent out 800 trained butter and cheese makers and has also taught nearly 2,000 young men butter making on the farm, as distinct from the creamery. The short course in agriculture at this institution was reported in 1899 to have had 190 students in attendance, and its practical outcome is thus stated by the dean: "We have found places on farms this year for more than fifty young men, who will secure from \$2 to \$10 more per month because of their training with us."

Another interesting special school is that for training sugar experts, which has been in successful operation for a number of years at Audubon Park, New Orleans, in connection with the State university, and has received financial assistance from the Sugar Planters' Association.

UNIVERSITY EXTENSION IN AGRICULTURE.

The term "university extension" has been used in recent years to denominate in a general way the efforts of our colleges to promote the diffusion of knowledge outside of their own halls. Though not always spoken of under this head, no university extension movement in this country has actually been so widespread as that on behalf of agriculture. Broadly speaking, this would properly include the dissemination of agricultural information through the publications of the experiment stations and this Department. The stations annually issue over 400 publications, which are distributed to mailing lists aggregating half a million addresses, and this Department supplements these with some 600 others, of which about 7,000,000 copies are distributed. But confining ourselves to what would more usually be considered university extension work, we find the colleges of agriculture largely engaged in conducting farmers' institutes and home-reading courses and helping to introduce nature study into the common schools.

IMPORTANCE OF FARMERS' INSTITUTES AS FACTORS IN EDUCATION.

The farmers' institutes are sometimes under the direct management of the agricultural colleges and sometimes are controlled by independent State officers, but in either case the colleges do much of the actual teaching in them and in various ways contribute largely to their success. These institutes are regularly held in over forty States. It is estimated that about 2,000 institutes were held in the United States last year, which were attended by half a million farmers. The importance of the institutes as factors in the general education of farmers in some of the States where they have been most successful may be indicated by the following brief statistics:

In Wisconsin there are now annually held 120 institutes, with an average attendance of over 50,000 persons. Sixty thousand copies of their annual institute bulletin, in which the best addresses are grouped together, making a book of over 300 pages, are annually distributed. A copy of this book is put into every school library in the State. For this work the State appropriates \$12,000 annually.

In Massachusetts 125 institutes are held, with an attendance of about 11,000 farmers.

In West Virginia over 60 institutes are held, with a total attendance of 14,000.

In Minnesota 50 farmers' institutes are held of two or three days each, with an attendance of from 300 to 1,000, and 25,000 copies of their annual report are distributed.

In Indiana an attendance is reported of over 25,000, with an average of 272 persons in about 100 institutes.

In Kansas 135 institutes are held, with a total attendance of 20,000.

In Michigan institutes are held in nearly every county, and the total attendance is reported to reach 120,000.

In Nebraska 60 institutes are held, with a total attendance of over 26,000.

In Pennsylvania some 300 institutes are held, with a total attendance of over 50,000.

In Ohio 250 institutes in 88 counties are held, with an aggregate attendance of about 90,000.

In New York over 300 institutes are held in a single year.

In California about 80 institutes are annually held, with a total attendance of 16,000.

HOME-READING COURSES IN AGRICULTURE.

The agricultural colleges in a number of States, notably in Pennsylvania and New York, are carrying on courses of home readings in agricultural subjects. These at present are developing into what may very properly be called correspondence courses. Not only are lists of books furnished by the college, but series of lessons with questions are sent out, and much correspondence is had with the persons following the courses. College officers also visit classes or clubs of farmers who are pursuing these courses to give them advice and instruction along the lines in which they are reading. Thousands of farmers are already enrolled in these courses, and only lack of funds prevents their rapid extension.

SECONDARY COURSES IN AGRICULTURE.

Thus far comparatively little has been done in the United States toward the establishment of schools of agriculture of secondary or high-school grade. As previously stated, a successful school of this grade is maintained at the University of Minnesota, and a similar one has been begun at the University of Nebraska. The agricultural courses maintained in a number of the institutions for colored students in the South are of this grade. In Alabama provision has also been made for secondary schools of agriculture for white students in the nine Congressional districts. There are a few private schools in which agricultural subjects are taught. There is some agitation in favor of the introduction of agriculture in the public high schools, but no definite movement in this direction has as yet been attempted. Meanwhile, however, books of reference and text-books on agricultural subjects suited to this grade of schools are being published in increasing number, and the way is thus being prepared for more rapid development of secondary courses of instruction in the schools in the near future.

AGRICULTURE IN THE COMMON SCHOOLS.

While there has been much agitation at different times during the present century in favor of introducing agriculture into the common schools, thus far no widespread efforts to do so have been made. Under present conditions, it appears to most persons who have made a careful study of the subject that very little can successfully be done in this direction until much preliminary work has been bestowed on the formulation of courses in nature study suited to the needs of the rural schools, on the training of teachers in this line, and on the general introduction of nature teaching in the schools. The success which is attending the movement on behalf of nature study in New York, Indiana, Pennsylvania, and elsewhere is so pronounced that there is good reason to hope that it will ere long secure the general recognition of the value of nature study for young children and its widespread introduction into the common schools. Important features of this movement are the strong indorsement which it is receiving from school officers and teachers, and the fact that nature study has already become quite generally a part of the curriculum in the graded schools of the cities. As this movement in the interest of the rural schools is being led by the agricultural colleges, agriculture seems likely to have its claim fully recognized in the formulation of nature-study courses. Already many of the lessons used in such courses are on subjects directly related to agriculture. Wisely planned and effectively taught, courses on natural objects and phenomena in the common schools will not only train the powers of observation of the children, but will interest them in the subjects included in the theory and practice of agriculture, and thus pave the way for the successful introduction of this complex subject in courses of higher grade.

PRESENT CONDITIONS AND PROSPECTS FOR THE FUTURE.

In general, the century now closing has witnessed an intellectual awakening of the farmers of this country, the volume and depth of which have been increasing with greatly accelerated speed in the past few years. We now have a considerable body of well-trained investigators, teachers, and other promoters of agricultural progress who are working earnestly and with greater success each year to raise the general intelligence of farmers and give them accurate and definite information for the improvement of their art; we have the widespread dissemination of knowledge on agricultural subjects through the press and through public agencies liberally endowed by the States and the nation; we have strong local, State, and national organizations which are laboring diligently for the promotion of the general and technical education of the farmers. Strong institutions for original research and higher education in agriculture have already been built up, and hopeful beginnings have been made in the formulation and introduction of more elementary courses of instruction in agriculture in schools of various grades and among the farmers generally. We shall therefore enter the twentieth century with a reasonable expectation that the education of our farmers in agricultural lines will go on increasing in efficiency and extent, and ere long become general and satisfactory.

PROGRESS IN THE TREATMENT OF PLANT DISEASES IN THE UNITED STATES.

By B. T. GALLOWAY,
Chief of Division of Vegetable Physiology and Pathology.

INTRODUCTION.

In looking back over the work of the past century in the treatment of plant diseases, two facts immediately enlist attention: (1) That the last fifteen years have witnessed by far the greatest advances made, and (2) that in every step taken there has been shown the characteristic American spirit of striving to get direct practical results as quickly as possible. For the first three-quarters of the century there was practically no systematic attempt to obtain light on the diseases of crops. Of course, diseases have been recognized as long as plants have been grown, but in all these earlier years it was the custom to regard them more in the nature of obstacles, against which it was practically useless to contend, than as subjects for study and thought.

PRESENT CLASSIFICATION OF PLANT DISEASES.

A few words at this point in regard to present methods of classifying plant diseases will perhaps make clearer the discussion to follow. Briefly stated, diseases may be produced in three ways: (1) By living organisms acting as parasites; (2) by unfavorable environment in which the plant grows; and, (3) by combinations involving both organisms and environment. No line can be drawn between these groups, for their relations and interrelations are so intimate that sharp separation at any point is out of the question. The living organisms, such as fungi, bacteria, etc., produce diseases by attacking the higher plants and destroying them in order to build up their own structures. On the other hand, when the surroundings, such as unfavorable soil, too much or too little food, improper cultivation, excess of water, insufficient aeration of the soil, or other similar conditions occur, disease may follow without the action of such organisms as fungi or bacteria.

It might, however, be held that the plant ought not to be subject to disease produced by organisms, for if it were surrounded by conditions exactly suited to its growth and was at all times able to adapt itself to these conditions, growth would in a measure be perfect, consequently no disease could be produced by outside agencies. But the plant is always in a state of unstable equilibrium, and it is this fact that makes it subject to the attacks of organisms and likely to be injured when any marked change of environment occurs. While this appears to be an element of weakness, it nevertheless affords vast opportunities, and is really the keynote to successful plant culture, as the writer will endeavor to show farther on.

EARLY THEORIES ON PLANT DISEASES.

It is not surprising that the man who grows plants looks to the weather as the source of all that is good or bad. In his own way he learns by experience that the weather has an important relation to the success or failure of his work, and he soon begins to connect certain weather conditions with what he sees going on about him. In all the early literature, therefore, references are found to the effects of "unfavorable weather," "meteorological disturbances," etc.

Other facts gained by long experience were also brought to bear on peculiar phenomena connected with plant diseases and their treatment. Thus, it was known at the beginning of the century and earlier that the injury from wheat rust was influenced by the presence of the common barberry plant. So strong was this conviction that laws were passed prohibiting the growing of barberry for ornament or for hedges. The opinion prevailed that the barberry caused rust, but it was not until many years later that its connection with rust was shown scientifically by the investigations of De Bary in Germany. It was also believed by many of the older agriculturists that smut was the direct result of a rupture of the cells of the plant itself, and that the rust of wheat was often produced by similar causes. Not only was this the general belief among many agriculturists, but it was credited by a number of workers abroad who made special studies of the subject.

About the year 1845, largely through the efforts of one or two investigators abroad, light began to dawn upon the nature of a number of the common diseases of plants, and these efforts were destined to have a marked influence on all future knowledge bearing on this subject. Although there was as yet no systematic attempt in this country to make special investigations, the work done abroad was gradually made known here, and through the agricultural press and other sources, became more or less familiar to farmers and others interested.

The great prevalence of the potato-rot fungus about this time (1845) gave a decided impetus to work on plant diseases. The rot swept over the earth, and many attempts were made to discover its cause and to provide a remedy. The relation of the parasite to the disease was worked out in Germany, and this knowledge soon became known to the farmers of this country. The same was true of wheat rust, corn smut, etc., so that even in these early days there was some knowledge of treating diseases by the direct use of remedies or preventives. This is particularly true of the smuts, which were among the first diseases to be controlled by the use of substances designed to destroy the reproductive bodies of the fungi themselves. Aside from this, the principal efforts in the way of treatment were in the direction of giving the plants the best surroundings possible and treating wounds by the use of simple paints, wax, etc.

Experience had taught that blight of the pear and apple must be cut out, although believed to be due entirely to "atmospheric influences." This emphasizes the important fact that has already been referred to, that is, that although the growers of plants did not, as a rule, concern themselves much with the causes of diseases, their experience had taught them certain methods of treatment which in some cases are even to-day accepted as the best that can be followed.

THE BEGINNING OF MODERN RESEARCH.

From 1845 until 1861 there was considerable advance in knowledge concerning plant diseases, particularly as regards their causes, or in other words, the relation to them of certain parasitic organisms. This knowledge came about largely through the investigations of a few men in Europe. From 1861 to 1873 the accounts of investigators abroad were published from time to time in our horticultural and agricultural reports and in agricultural and other journals. There was an increasing interest in the subject, however, and it is not surprising that in 1873 and 1874 there was a marked tendency to advance in knowledge along these lines.

Prof. T. J. Burrill, of the University of Illinois, was one of the pioneers in this field. Early in 1874 he commenced publishing articles on the parasitism of fungi and the relation of various organisms of this kind to such diseases as leaf blights, rusts, and other maladies. The following year Dr. W. G. Farlow, of Harvard University, began a series of papers which were epoch making in their nature. These papers dealt with a number of important diseases of plants and treated them in a masterly way. Although up to this time knowledge as to combating such diseases was limited, the information obtained in regard to the life histories of the organisms and the manner in which they attack the host plants and cause their death was of great value in suggesting lines of action looking toward prevention. Farlow's papers were followed by similar ones by Halsted, Bessey, Trelease, Earle, Arthur, and others.

Early in the eighties the interest in the subject became marked, as may be seen by the increased number of papers and the fact that some of the universities and colleges were devoting time to lectures and studies relating to the work. The State agricultural experiment station at Geneva, N. Y., inaugurated some important work under the direction of Dr. J. C. Arthur, who was made botanist of the station in 1884, and whose work was almost entirely on the diseases of plants. This was really the first systematic attempt on the part of any station or organized body in the United States to undertake a thorough study of the subject. Dr. Arthur published four reports, which dealt with a great number of important diseases. He paid particular attention to pear blight, which was recognized as one of the most destructive diseases of fruit in the United States, and had already been shown by Dr. Burrill to be due to bacteria. Dr. Arthur's work tended to establish more thoroughly the parasitic nature of a number of fungi. The keynote to the practical work of treatment had not yet been struck, but was to come later as a natural result of the studies made at this time.

THE EPOCH-MAKING PERIOD FROM 1885 TO 1895.

A careful study of events, such as are to be described here, shows that in nearly every case where a line of work stands out preeminently as having a marked influence on the welfare of a country, two things have conduced to this end: (1) Through writings, lectures, and other channels the public has been educated so as to understand its need in this direction, and (2) after the recognition of this need there has been the proper direction of the forces necessary to satisfy it.

Prior to 1885 much had been done toward educating the farmers and fruit growers to the necessity of protecting their crops. There was a well-grounded belief that many of the common and destructive diseases owed their existence to causes which could be discovered, and which if once known might be controlled. The time, therefore, was ripe for starting the work on a more extensive scale than had ever been done before. The demand at this time was largely for information as to the best methods of treatment from a practical standpoint. It was not so much a question of knowing what the diseases were as it was how to best get rid of them. Recognizing these questions and their importance, the Department of Agriculture inaugurated some work which was destined to have far-reaching effects. F. Lamson-Scribner, who was assistant botanist at the time, was active in bringing about a proper recognition of the importance of the work. He undertook the publication of papers, which appeared first in the report of the Botanist of the Department of Agriculture. Soon such an interest was awakened that the Commissioner of Agriculture, Hon. Norman J. Colman, took steps to have the work put on a sound basis. Small appropriations were obtained, and the Section of Mycology was established as a distinct branch in the Department. Fortunately, a great impetus was given to the work at this time by the efforts being made in France to find remedies for the downy mildew of the grape. When black rot, another American disease, appeared in the French vineyards, there was widespread alarm, and consequently renewed efforts to find means of checking it.

It is well to call attention to the marked difference in the conditions existing in France and in this country with respect to such matters. Our country is so great, and the possibilities of diversified culture so numerous, that many farmers and fruit growers do not feel the necessity of putting forth any marked effort in treating the diseases. In France, however, the life of the community itself depends in many cases on the success or failure of a particular crop in that community, and so it was that the greatest pressure was brought to bear on the French Government to make a determined effort to check the ravages of downy mildew.

Through a fortunate accident—the sprinkling of vines bordering a roadside with bluestone and lime in order to prevent the pilfering of the fruit—there was discovered about 1885 a fungicide which was to have a marked influence not only on the welfare of France, but also on the interests of America as well. This fungicide thus accidentally discovered is the so-called Bordeaux mixture, which is made by combining copper sulphate, or bluestone, with lime. It has long been known that copper in various forms is able to destroy fungus spores, but it was not until the discovery of the Bordeaux mixture that a great impetus was given to the study of its effects on many plants. No one could have imagined the consequences which were to come from the combined use of two such simple things. Not only was the fruit saved from the thieves, but it was protected against mildew as well.

Soon after the success in France in the treatment of grape mildew with Bordeaux mixture, its usefulness was noted in this country by the Department of Agriculture and also by others. It was difficult, however, to convince fruit growers of the importance of making thorough trials of this and other preparations. This was one of the greatest obstacles that the Department met with in the early stages of the work. However, circulars were sent out describing the preparation of the fungicide and suggesting diseases that might be effectively treated with it. The success of the work was marked. Immediately there sprang up probably one of the most remarkable series of investigations and experiments ever witnessed in this or in any other country. Fungicides of many kinds were proposed and tested on a large scale, and extensive lines of investigation were inaugurated not only by the Department of Agriculture, but also by private individuals in various parts of the country.

In 1887 Professor Lamson-Scribner severed his connection with the Department of Agriculture, accepting an appointment to the chair of botany in the University of Tennessee, and the Department's work in this line was put in charge of the writer. The investigations were pushed forward as vigorously as possible; new lines of investigation were inaugurated, and a special effort was made to bring about practical results. Black rot of the grape was successfully treated in 1887, and the same year decisive results were obtained in controlling several potato diseases.

A great impetus was also given to the work in 1887 by the establishment of the agricultural experiment stations. By means of these stations it was made possible for many of the States to inaugurate work not only in the study of plant diseases and their treatment, but also in many other lines of investigation as well. Several of the stations immediately commenced investigations, and as a result for the next eight years the educational work done throughout the country had the most remarkable effect in putting farmers, fruit growers, and others in possession of knowledge most valuable to them. During the period under consideration a revolution was wrought in our horticultural methods, and, as a result, it is now as rare to find people who are not thoroughly convinced of the importance of spraying as it is to find those who are satisfied that the cultivation of the soil is not necessary.

This vast amount of work on the fungicides carried with it the necessity of providing suitable apparatus for the application of the various preparations, there being a great need for such apparatus when the work was started. Just prior to the beginning of the important line of work in 1885 attention had been called to the value of the cyclone nozzle, an apparatus invented by Dr. W. S. Barnard while connected with the United States Entomological Commission. Although this nozzle was designed for the application of insecticides, it was found that with some minor changes it would be equally as valuable for use in connection with fungicides. There was also an urgent need in 1887 for suitable power pumps for the application of the various preparations. Some advances had been made with such apparatus in France, particularly in the knapsack forms, but such of these as were in actual use were more or less cumbersome, and none could be obtained in this country. Early in 1887 the first American knapsack pump was put on the market, largely through the efforts of Col. A. W. Pearson, of Vineland, N. J., who was one of the pioneers in the work of treatment. The machine was somewhat complicated, however, and did not attract the attention that it really deserved. In 1888 the writer devised a new form of knapsack spray pump, which was soon put on the market, and this became the pattern from which many designs have been made. In a few years such was the demand for apparatus of this kind that numbers of machines were manufactured. The knapsack forms of sprayers have had a marked influence in the success of the work described. Through them it was made possible to apply the remedies in the most thorough manner, a feature which is of the greatest importance in such work. As a direct result of this work many other forms of sprayers were designed; in fact, in this feature of the investigation the United States can well claim to have constantly led the way.

SOME RESULTS OF THE WORK.

The ten years' work just described was unique in its way. There was a united effort to concentrate on as many practical problems as possible, with a view of solving these first and attending to the more difficult ones later. Immediate results were demanded, and by obtaining them confidence was engendered; and thus the foundation for future efforts was laid. Within the limits of such a paper as this, it is not possible to review all the direct practical results of the work in question, but a few examples will suffice.

GRAPE GROWING.

One of the most striking examples of results obtained is furnished by the grape. Grape growing in this country has had a curious history. At the beginning of the century numerous attempts had been made to introduce and grow the foreign or European varieties. It was recognized that in this vast country abundant opportunities were offered for the production of grapes and the manufacture of wine. Our native varieties were not considered of value, and for this reason all the early efforts were put forth in importing and testing the foreign, or Vinifera, vines. All the attempts in this direction, however, proved disastrous, mainly on account of several diseases, which, from all that can be gathered, were the same as those known to-day as downy mildew and black rot.

After many discouraging attempts to successfully cultivate these European vines, the work was in a measure abandoned and attention was turned toward our native varieties, many forms of which were found growing in the woods. Some of these vines proved to be resistant to the diseases, no doubt because through a long struggle for existence there had been a survival of the fittest, and these were by nature endowed with the ability to resist the various maladies which had been so destructive to European vines. The diseases being American, the European vines had had no chance to develop anything like natural resistance before being attacked.

The discovery of the value of some of our native kinds gave the grape industry a new impetus, but as soon as vineyards began to increase and cultivation brought about changes in the vines themselves it was found that the latter were becoming more and more subject to the attacks of their old enemies. Consequently there are recorded many disastrous failures in grape culture between 1850 and 1860, when mildew and black rot were veritable scourges. In a number of places where grape culture had been very profitable the vineyards had to be abandoned. New localities, in which the grape had not been tried, were now planted to vineyards, and for a time these produced remunerative yields, but it was only a question of time when the diseases reached these places and it became necessary to abandon them and again seek more favored localities.

By 1885 grape growing had been tried in most of the important sections of the country, and as the diseases continued to spread it was realized that something would have to be done or else the industry would have to be abandoned. At this time the work of the Department of Agriculture commenced, but so many efforts had already been put forth to control the diseases and there had been so many failures that it required a great deal of encouragement to induce growers to even make thorough trials of the treatments proposed. By carrying on experimental work in typical regions, however, and by demonstrating by actual trials that the treatments were effective (fig. 1), the value of the work was fairly established, and consequently fungicidal treatments were rapidly adopted. The money value of this

FIG. 1.—Grapes from vineyard affected with black rot: Sprayed and unsprayed.

work to the grape grower can not be estimated. It has given viticulture a new lease of life and has furnished profitable employment in many regions which otherwise would have been abandoned, so far as this crop is concerned.

NURSERY-STOCK DISEASES.

Prior to 1887 no attempt had been made to control the many serious diseases which affect nursery stock in this country. The nursery interests had assumed immense proportions and the value of the output was worth millions of dollars. Nursery stock, such as apples, pears, plums, cherries, etc., had long been subject to a number of serious diseases, which mainly affected the foliage. Often as a result of these injuries it was found impossible to properly bud the stock, and a large part of it was therefore rendered worthless.

In 1888 the Department of Agriculture inaugurated the first experiment with a view of finding some means of holding these diseases in check. After several years' work it was clearly shown that some of the most destructive maladies could be controlled (fig. 2). Spraying nursery stock, therefore, has come to be a general practice, and has been the means of saving thousands of dollars to the growers every year. The Department and the State stations have gone hand in hand in this work, and some of the most striking features of the practical side of the investigations have come about through the efforts

FIG. 2.—Treatment of peach leaf curl: Sprayed and unsprayed trees. (Pierce, Cal.)

of the latter. Potato scab, the smuts of cereals, and many other diseases are now controlled as a result of the good work done by these organizations.

DEVELOPMENT OF EDUCATIONAL FEATURES.

Perhaps there is no more striking instance of the growth of this subject than that witnessed in the development of the educational features connected with it. In 1885 there were only three institutions besides the Department of Agriculture making an organized effort in the way of teaching or in experimental work of this character. Ten years later there were fifty colleges and stations engaged in the work, and no less than one hundred special investigators were devoting their time to it.

THE PRESENT AND THE FUTURE OF PLANT PATHOLOGY.

Since 1896 there has been a marked tendency toward a higher appreciation of a true science of plant pathology. The outlying problems have in a measure been solved and opportunity has been given to survey and take a clearer view of the fundamental questions upon which the future success of the work must depend. We are far enough along to see that a new epoch has begun—one which we believe is to place this country in advance of all others in getting the most from the soil with the least expenditure of time and money. Our farmers and fruit growers are intelligent, quick to perceive, and quick to act. They are now in possession of knowledge which gives them a decided advantage over their competitors in other countries, and therefore it will not be difficult with such men and such conditions as we have to build up a science which will have a marked influence on the welfare of the country.

What then are the lines along which this science is to be built? First, we must recognize more plainly the possibilities within the plant—its plasticity and its ability to change; second, we must learn to look more carefully outside of the plant, that is, at its environment and the effects this may produce; and, third, we must discover the principles whereby the grower of plants shall be able to bring about such perfect harmony between the plant and its environment that an approximately ideal organism will result. This means that our aim should always be toward making two blades of grass grow where only one grew before.

The foundation of this work is physiology, involving a study of the phenomena of life itself. Here we learn the possibilities of future development, and here hinge the vital questions relating to nutrition and heredity. The pathology of the future, therefore, will not stop at the mere correction of conditions involving the loss of a crop or part of a crop. It will put within the power of the intelligent grower knowledge that will enable him to forestall injuries by furnishing conditions best suited to the development of the plant. We must bring to our aid many lines of work. Plant breeding will enable us to attain ideal forms. Selection will make it possible to fix these forms within certain limits. Nutrition goes hand in hand with breeding and selection. Chemistry and physics play important parts, and in the study of pathological phenomena themselves other branches of science will be brought to bear. Thus, as we have pointed out elsewhere, the highest aim of the investigator in this field will be not to deal with effects only, but to study causes, for it is only by such means that the greatest good can be accomplished.

THE RELATION OF CHEMISTRY TO THE PROGRESS OF AGRICULTURE.

By Dr. H. W. Wiley
Chemist.

Introduction.

This paper will be devoted, in so far as possible, to the progress of agriculture in the United States during the nineteenth century. Inasmuch, however, as the factors of a chemical nature influencing agriculture are largely made up of forces emanating from other countries, it will not be possible to separate entirely the discoveries made in foreign countries from those made in the United States.

In order to keep the paper within suitable limits for the Yearbook, no attempt will be made to trace the progress of agriculture in its relation to chemistry from year to year, and the subject will be considered from three principal points of view only, namely:

(1) The relation of chemistry to agriculture at the beginning of the century.

(2) The impetus given to scientific agriculture in its relation to chemistry by the discoveries of Liebig, Gilbert, Boussingault, and other workers, which began to produce effects about the middle of the century.

(3) A résumé of the relations of chemistry to agriculture up to and at the present time, with a brief reference to the principal methods whereby chemical research has been made useful to practical agriculture.

The above is not only a convenient division of the whole subject for the purpose of discussion, but it also portrays the three principal epochs in the relations of chemistry to agriculture for the century.

From a chemical point of view, the knowledge of scientific agriculture, as it existed at the beginning of the century, was practically all that was known until near its middle point, when the work and researches of the distinguished men mentioned and others associated with them were beginning to have practical application. From this point onward to the present time the influence of chemical research on progressive agriculture has been more and more felt through certain lines of investigation, until it has brought the science of agriculture to its present condition.

In a statement of that part of the subject relating to chemistry and agriculture at the beginning of the century it will be sufficient to refer to the standard works which were published at or about that time, and which are still accessible in our libraries. The literature of the middle of the century is so voluminous that only a brief reference to it can be given. In a discussion of the third division of the subject, or a review of the relations of chemistry to agriculture to the present time, etc., the progress of agriculture under the influence of chemical studies and researches will be considered in the briefest possible manner in several typical lines, among which may be mentioned: First, the teaching of agriculture in schools, colleges, and universities; second, the agricultural colleges and experiment stations; third, the agricultural press; and, fourth, the chemical studies conducted under the auspices of the Department of Agriculture, including those collected in the reports of the Patent Office relating to agriculture, which began to issue shortly before the middle of the century.

The attitude of chemical science toward agriculture at the beginning of the century may be presented under three divisions:

(*a*) The knowledge which was possessed concerning the nature of the soil and its relation to plant growth.

(*b*) The knowledge possessed concerning the nature of manures and the manner in which they increase the yield of crops.

(*c*) The prevalent ideas concerning the composition of agricultural crops in relation to their demands upon the soil and upon fertilizers.

Status of Agricultural Chemistry at the Beginning of the Century.

Under this head will be given, first, a summary of the state of knowledge at or about the beginning of the century in regard to the above several points, and second, some brief observations of a general nature on the soundness or unsoundness of the views then held.

Fortunately for the purpose of this part of the paper, the relations of chemistry to agriculture at the beginning of the century have been accurately and faithfully portrayed in works appearing near that period and still accessible. Among these may be mentioned:

A work of great scientific importance entitled "The Natural and Chemical Elements of Agriculture," translated from the Latin of Count Gustavus Adolphus Gyllenborg by John Mills, published in London in 1770.

"The Spectacle of Nature," translated from the French by Mr. Humphreys, the first edition of which was published about the beginning of the century, and the second edition, to which the writer has had access, about 1807.

The most important work, however, from a scientific point of view, and that which gives the most accurate statements pertaining to the relation of chemistry to agriculture, is a compilation of the lectures of Sir Humphry Davy. These lectures, delivered before the Royal Agricultural Society of England, were first published in England in 1813 and republished in this country in 1815 by John Conrad & Co., of Philadelphia, Pa.; Fielding Lucas, jr., of Baltimore, Md.; Robert Gray, of Alexandria, Va., and William F. Gray, of Fredericksburg, Va.

Another work of a more popular nature, and yet containing a résumé of the knowledge of that time concerning the relations of chemistry to agriculture, is entitled "The Rural Socrates; or, An account of a celebrated philosophical farmer, lately living in Switzerland, known by the name of Kliyogg." It was translated from the German by Benjamin Vaughan, a writer distinguished in many fields of work and a personal friend of Joseph Priestley. This work was published in Hallowell, Me., by Peter Edes in 1800.

Chemistry as a science has undergone such a wonderful transformation during the century as to make any just comparison of its relation to any particular industry at the present time with that it held a hundred years ago somewhat difficult. We regard with a feeling akin to compassion the ideas entertained one hundred years ago in reference to chemistry, especially in its relations to agriculture; but the pride we may feel in our present knowledge of this science should not be allowed to carry us too far, since at the end of the next century the writer who shall undertake a review of this subject may look with equal compassion on the views we now entertain.

The efforts which were made by Lavoisier and his school to place the science of chemistry upon a sure foundation some twenty-five years before the beginning of the century, although making great progress, had not yet entirely dominated the world of chemical theory. The crude notions of the earlier chemists concerning phlogiston, phlegms, essential oils, exudations, evaporation, and other processes still held sway, and agricultural chemistry was probably the last of the different branches of chemical science to be liberated from the thraldom of these erroneous theories. In spite of this fact, however, the observations which scientific men had made of the chemical aspects which agricultural science possessed are not without value nor are they wholly false.

KNOWLEDGE OF THE COMPOSITION AND FUNCTIONS OF SOILS.

By far the most accurate account of the composition of the soil, as it was understood at the beginning of the century, is furnished by Sir Humphry Davy.[1] According to Davy the substances which constitute the soil "are certain compounds of the earths, silica, lime, alumina, magnesia, and of the oxides of iron and magnesium; animal and vegetable matters in a decomposing state, and saline, acid, or alkaline combinations." Minute descriptions are given of the various elements composing the soil, and for the most part these descriptions represent the state of our knowledge even at the present time. Silica is described as a compound of oxygen and silicum. Lime is

[1]Agricultural Chemistry, pp. 154 *et seq.*

stated to exist in soils usually united with carbonic acid, and sometimes with phosphoric and sulphuric acids. Lime itself is said to consist of 40 parts by weight of calcium and 15 of oxygen, which is very nearly the composition assigned to the substance CaO at the present time. Alumina, with less accuracy, is described as being composed of 33 parts by weight of aluminum and 15 of oxygen. Magnesia is described as existing in combination with carbonic acid. Two oxids of iron are mentioned, the brown and the black, and their chemical composition as understood at that time is given. The oxid of manganese, or manganesum, as Davy calls it, is stated to be distinguished from the other substances found in the soil by its property of reducing muriatic acid and converting it into chlorin. Vegetable and animal matters are to be known by their sensible qualities and by their property of being decomposed by heat. The saline compounds of soils are described as common salt, sulphate of magnesia, sometimes sulphates of iron, nitrates of lime and of magnesia, sulphate of potassa, and carbonates of potassa and soda. These compounds Sir Humphry regards as of so little importance that he says it is not necessary to describe their characteristics minutely.

The methods of soil analysis, many of which are still in use at the present time, are fully described. Upon the whole, most of them, however, are crude and unsatisfactory, and could not possibly have led to correct ideas of the composition of the soil. Davy further adds: "In the first trials that are made by persons unacquainted with chemistry, they must not expect much precision of result. Many difficulties will be met with; but in overcoming them the most useful kind of practical knowledge will be obtained, and nothing is so instructive in experimental science as the detection of mistakes. The correct analyst ought to be well grounded in general chemical information; but perhaps there is no better mode of gaining it than that of attempting original investigations."

Davy fully recognized that the soil is the source of nourishment for plants, as he says in another place: "Plants being composed of no locomotive powers, can grow only in places where they are supplied with food; and the soil is necessary to their existence, both as affording them nourishment and enabling them to fix themselves in such a manner as to obey those mechanical laws by which their radicles are kept below the surface and their leaves exposed to the free atmosphere. As the systems of roots, branches, and leaves are very different in different vegetables, so they flourish most in different soils. The plants which have bulbous roots require a looser and a lighter soil than such as have fibrous roots, and the plants possessing only short fibrous radicles demand a firmer soil than such as have taproots or extensive lateral roots."

Of vegetable and animal matters Davy says: "Vegetable or animal matters when finely divided not only give coherence, but likewise softness and penetrability; but neither they nor any other part of the soil must be in too great proportion, and a soil is unproductive if it consist entirely of impalpable matters." He says of mineral constituents: "Pure alumina or pure silica, pure carbonate of lime, or carbonate of magnesia are incapable of supporting healthy vegetation. No soil is fertile that contains as much as 19 parts out of 20 of any of the constituents that have been mentioned."

Again, he says: "In all cases the ashes of plants contain some of the earths of the soil in which they grow; but these earths, as may be seen by the table of ashes afforded by different plants given in the last lecture, never equal more than one-fiftieth of the weight of the plant consumed. If they be considered as necessary to the vegetable, it is as giving hardness and firmness to its organization. Thus, it may be mentioned that wheat, oats, and many of the hollow grasses have an epidermis principally of the siliceous earths, the use of which seems to be to strengthen them and defend them from the attacks of insects and parasitical plants."

The physical quality of earths in their relation to water are fully exploited by Davy. He says: "The power of soils to absorb water from the air is much connected with fertility. When this power is great, the plant is supplied with water in dry seasons, and the effect of evaporation in the day is counteracted by the absorption of aqueous vapor from the atmosphere, by the interior parts of the soil during the day, and by both the exterior and the interior during the night."

In regard to the food of plants, Sir Humphry states: "Water and the decomposing animal and vegetable matter existing in the soil constitute the true nourishment of plants, and as the earthy parts of the soil are useful in retaining water, so as to supply it in the proper proportions to the roots of the vegetables, so they are likewise efficacious in producing the proper distribution of the animal or vegetable matter; when equally mixed with it, they prevent it from decomposing too rapidly, and by their means the soluble parts are supplied in proper proportion."

In speaking of the derivation of soils from rocks, he says: "The best natural soils are those of which the materials have been derived from different strata, which have been minutely divided by air and water and are intimately blended together; and in improving soils artificially the farmer can not do better than imitate the processes of nature. The materials for the purpose are seldom far distant; coarse sand is often found immediately on chalk, and beds of sand and gravel are common below clay. The labor of improving the texture or constitution of the soil is repaid by a great permanent advantage; less manure is required, and its fertility insured. The capital laid out in this way secures forever the productiveness and consequently the value of the land."

Commissioner Newton, in his first Annual Report, paid a fitting tribute to the services of Sir Humphry Davy in establishing agricultural chemistry as a separate department of science. He says, speaking of the board of agriculture established by Pitt in 1793:

More than all, the board was instrumental in employing Sir Humphry Davy to make those experiments which are not only an honor to intellect, but which established agricultural chemistry as a department of science, and are of inestimable value. He delivered his lectures on this subject in 1802. The fundamental principle which he develcped and demonstrated was this—that the productions of the soil derive their component elements, which for the most part are hydrogen, oxygen, and nitrogen, either from the atmosphere by which they are surrounded or from the soil in which they grow. He showed that the process of vegetation depends upon the perpetual assimilation of various substances to the organs of the plants in consequence of the exertion of their living powers and their chemical affinities, stimulated chiefly by moisture, light, and heat. The discoveries in chemical science before Davy's time had undoubtedly prepared the way for his triumph, but he is none the less entitled to praise. He first recognized a plant as a living thing, the laws of whose existence were to be studied in order to develop a perfect growth. He showed, by analysis of soils and plants, what properties and conditions would best furnish the elements needed in cultivation.

KNOWLEDGE OF FERTILIZERS AND MANURES.

The chemical knowledge of the composition and functions of fertilizers at the beginning of the nineteenth century was extremely nebulous. Experience of a wholly empirical nature had shown from the earliest history of agriculture the value of certain refuse products of the stable and the barnyard in increasing the yield of crops; but the component parts of these materials and the manner in which they acted were entirely unknown. It was the custom in many of the older countries for the farmers to increase the litter of the farmyard by gathering leaves and twigs, which were used in bedding the animals. As, for instance, it was said of Kliyogg: "He is attentive also to gather all the dried leaves, moss, and rushes from his ground that can serve for litter. * * * A compost dunghill appears to him an object of so great importance to the improvement of land that of all branches of labor he regrets the want of assistance in this the most. * * * In prosecution of this design, in autumn, during the moon's increase, Kliyogg goes into his wood with a hedge bill to prune the supernumerary branches of fir and pine trees. * * * These he binds into faggots and carries home. * * * At leisure hours, and especially in long winter evenings, he prepares these faggots for the purposes intended. * * * By this method he amasses many proper materials for good manure."[1]

Kliyogg was also careful to preserve the liquid manures which exuded from his stables, and for this purpose he constructed trenches in his cow houses. It is interesting to know that, unwittingly, he had

[1] The Rural Socrates; or, An Account of a Celebrated Philosophical Farmer, Lately Living in Switzerland, Known by the Name of Kliyogg, p. 8.

discovered the true function of much of this material, which he regarded as a ferment. The record says: "Thus placed, it receives the urine and dung of his cattle, and being always kept half full of water, it forms a thick mixture and serves as a ferment, with which a very great quantity of water may in a very short time be converted into liquid manure. One portion of this ferment being mixed with seven portions of the freshest spring water soon makes the whole become corrupt, especially if the reservoir in which the mixture is made is of wood and placed in a warm situation, or if an artificial heat is substituted in case a natural heat is wanting. By means of this fermentation an excellent manure is produced, which proves the best assistant which can be given to such meadow and arable lands as are naturally dry."[1]

The earlier accounts of scientific agriculture at the beginning of the century recognized the great value of gypsum as a fertilizing material. All the writers refer favorably to its use. The use of gypsum as a fertilizer is said to have been the discovery of the Rev. Mr. Meyer, pastor of Kupferzell, Germany. Mr. Meyer published a detailed account of the manner of using gypsum. According to the method described by him, gypsum should be spread in its natural state after being reduced to powder, and is useful upon meadows containing both the common and cultivated grasses. Mr. Meyer also found gypsum valuable with peas, vetches, lentils, oats, rye, and tobacco. Its most surprising effect, however, was upon clover, and this in soils the most dry and arid. On marshy ground it was found to produce no good effect. It is urged that gypsum should be spread upon the grass or grain before it begins to shoot. Upon meadows, the best time for spreading it is stated to be at the melting of the snow, and upon fields of grain, as soon as they are sown. Benjamin Vaughan, the translator of "The Rural Socrates," says that at the end of the last century and at the beginning of the present gypsum was used largely in the United States, and he refers to the writings of Judge Peters, Robert Morris, Dr. Mitchill, Mr. Bordley, and others on the subject.[2]

The use of marl was also fully understood at the beginning of the century. Since the time of the Roman conquest, and probably before, the marl beds of northern France and southern Belgium have been constantly exploited. Great hollows are found in many of the fields of northern France made by the excavation of marl many centuries ago. Kliyogg calls the marl bed "that mine of farming gold," and says: "I owe to this marl not only abundant harvests, but the character of my children. It is true that they murmured against me at first for employing them in hard labor, even during the winter. * * * But at length the rich harvests with which Providence blessed us

[1] The Rural Socrates; or, An Account of a Celebrated Philosophical Farmer, Lately Living in Switzerland, Known by the Name of Kliyogg, p. 128.

[2] Ibid., pp. 128 and 129.

forced them to confess that I had said nothing which was not both true and useful."[1]

The true function of marl, however, was but little understood, and even its chemical composition was practically unknown by those using it.

In the article on husbandry, in "The Spectacle of Nature," the Prior, in conversation with the Chevalier, says in regard to manure: "This manure, which completes what the dews of heaven had begun, is the most contemptible substance upon the face of the earth, and is chiefly composed of the litter taken from stables and sheepfolds; dove houses, hencoops, and the dwellings of all domesticated animals furnish manures that differ in their degrees of heat, and which being blended together, as well as quenched and corrected by each other, replenish the land with all the fertility it had lost." Among other substances which the Prior mentioned as being used for manures are straw, stubble, shells of pulse, useless leaves, refuse of garden herbage, rotten wood, chimney and oven soot, rags, hair of animals, cuttings of leather, skins of beasts, bark of trees, lees of wine, sediments of oil, malt dust, tanners' bark, dyers' lees, soapsuds, of which last it is said, "which are commonly thrown out of the laundry as useless, though soap is impregnated with oils and salts, which are the principal elements of plants."

The Prior also says: "No kind of manure has more prolific qualities than the soil which is swept from populous cities, and especially those where a great number of kitchens and dyers of wool are continually discharging into the streets a fat and oily sediment, which is very beneficial to corn."[2]

The value of ashes is fully recognized, in the essay on husbandry, by the Prior, who says that they can supply the place of all the rest if a sufficient quantity can be obtained. The ashes of wood are preferred to those of any other substance. He advises the burning of turf for the purpose of securing the ashes. The methods of forming composts with ashes are fully described.

The prevailing idea at that time that oil is one of the most valuable of manures is developed in his description, it being stated that "oil and salts constitute the chief merit of the manure."

The fact that the principal value of the ashes is due to the potash and phosphoric acid which they contain was not even suspected by the earlier scientific agriculturists. The early agriculturists in our country were imbued with the customs of their European homes in regard to the use and value of manure, although upon the virgin lands there seemed to be but little necessity for the application of fertilizing substances. The necessity of fertilizers, however, soon became evident, especially on lands planted continuously to cereals and to tobacco. When the first abundant crops, due to the virgin fertility of the soil, began to

[1] The Rural Socrates, pp. 143 and 144. [2] The Spectacle of Nature, pp. 231 and 232.

diminish, the colonists received a valuable lesson in the use of artificial fertilizers from Squanto, one of the leading Indians of the New England coast. In Governor Bradford's "History of Plimouth Plantation" is given an account of the early agricultural experiences of the Plymouth colonists. In April, 1621, at the close of the first long, dreary winter, "they [as many as were able] began to plant their corne, in which service Squanto [an Indian] stood them in great stead, showing them both ye manner how to set it, and after how to dress and tend it. Also he tould them, axcepte they got fish and set with it [in these old grounds], it would come to nothing; and he showed them yt in ye middle of Aprill, they should have store enough come up ye brooke by which they begane to build and taught them how to take it."

In George Mourt's "Relation; or, Journal of the beginning and proceedings of the English Plantation settled at Plimouth, in New England, by certain English adventurers, both merchants and others," London, 1622, it is said:

> We set the last spring some twenty acres of indian corn, and sowed some six acres of barley and pease, and according to the manner of the Indians, we manured our ground with herrings, or rather shads, which we have in great abundance and take with great ease at our doors. Our corn did prove well, and, God be praised, we had a good increase of indian corn, and our barley indifferent good.

Thomas Morton, in his "New England Canaan," London, 1632, wrote of Virginia:

> There is a fish (by some called shadds, by some allizes) that at the spring of the yeare passe up the rivers to spawn in the pond, and are taken in such multitudes in every river that hath a pond at the end that the inhabitants doung their ground with them. You may see in one township a hundred acres together set with these fish, every acre taking 1,000 of them, and an acre thus dressed will produce and yield so much corn as three acres without fish; and least any Virginea man would infere hereupon that the ground of New England was barren, because they use more fish in setting their corne, I desire them to be remembered, the cause is plaine in Virginea, they have it not to sett. But this practice is onely for the indian maize (which must be set by hands), not for English grain; and this is therefore a commodity there.

The following amusing quotation is from the records of the town of Ipswich, Mass., May 11, 1644:

> It is ordered that all the doggs for the space of three weeks from the publishing hereof shall have one legg tyed up, and if such a dogg shall break loose and be found doing harm the owner of the dogg shall pay damage. If a man refuse to tye up his dogg's leg, and hee bee found scraping up fish in a corn field, the owner thereof shall pay twelve pence damage, beside whatever damage the dogg doth. But if any fish their house lotts and receive damage by doggs, the owners of these house lotts shall bear the damage themselves.

It is thus seen that even on the old ground cultivated by the Indian before the advent of the colonists it was not possible to raise good crops except by the artificial manuring which has been described above. Little was known, however, of the nature of these fertilizing materials and the manner in which they nourished plants. The first real knowledge of fertilizing materials which was in vogue in this country came from the republication of Sir Humphry Davy's "Agricultural Chemistry" and its distribution throughout the colonies. It may be stated that this book produced the first real impression, of a scientific nature, of the relation of chemistry to the progress of agriculture. Many of the lectures given by Sir Humphry Davy were on the subject of manures, in which he treated of the manures of vegetable and animal origin, of the manner in which they became the nourishment of the plant, of fermentation and putrefaction, of mixed manures, of general principles in respect of the use and application of manures of mineral or animal origin, of fossil manures, of lime, of gypsum, of alkaline salts employed as manures, of alkalies, and of common salt. He also gave a lecture on the improvement of land by burning and the chemical principles which underlie this operation. He first announced the general principles that all manures must practically be dissolved before they can enter the organism of the plant. He says: "The pores in the fibers of the roots of plants are so small that it is with difficulty they can be discovered by the microscope. It is not, therefore, probable that solid substances can pass into them from the soil."[1]

Sir Humphry supposed that sugar was a valuable fertilizing material, because when he grew plants in a solution of sugar, jelly, and mucilage he found that they grew vigorously. He recognized the fact that vegetable and animal substances, before they can become useful as plant food, must be changed in some way, since he says, "They can only nourish the plant by affording solid matters capable of being dissolved by water or gaseous substances capable of being absorbed by the fluids in the leaves of vegetables. * * * The great object in the application of manure should be to make it afford as much soluble matter as possible to the roots of the plants, and that in a slow and gradual manner, so that it may be entirely consumed in forming the sap or organized parts of the plant. * * * Vegetable manures in general contain a great excess of fibrous and insoluble matter, which must undergo chemical changes before they can become the food of plants."[2]

Chief among these changes he regarded fermentation, thus recognizing at that early date the great principle of change which organic matters must undergo before they become useful as plant foods. Sir Humphry, however, was familiar only with the variety of fermentation which produced carbonic acid and alcohol, and of course had no knowledge of the really essential fermentation, from a fertilizing point of view, which such substances undergo. He, however, realized that there was a fermentation of a different kind, because he says: "Animal matters in general are more liable to decompose than vegetable

[1] Agricultural Chemistry, p. 269. [2] Ibid., pp. 272 and 273.

substances; oxygen is absorbed and carbonic acid and ammonia formed in the process of their putrefaction. They produce fetid compound elastic fluids, and likewise azote."[1]

The principal substances which are found in animal manures, according to Davy, are gelatin, fibrin, mucus, animal fats and oils, and albumin and urea. The effect of sterilization or pasteurization in preventing the decay of animal matters is fully recognized by Davy in describing what he calls "Appert's method of preserving animal and vegetable substances," which is practically the pasteurization of the present day. He says: "This method is by filling a vessel of tin plate or glass with the meat or vegetables; soldering or cementing the top so as to render the vessel air-tight, and then keeping it half immersed in a vessel of boiling water for a sufficient time to render the meat or vegetables proper for food. In this last process it is probable that the small quantity of oxygen remaining in the vessel is absorbed; for on opening a tinned iron canister which had been filled with raw beef and exposed to hot water the day before, I found that the minute quantity of elastic fluid which could be procured from it was a mixture of carbonic-acid gas and azote."[2]

It appears, therefore, that the process of pasteurization is at least as old as the nineteenth century.

Sir Humphry makes the following additional observation: "Where meat or vegetable food is to be preserved on a large scale for the use of the navy or army, for instance, I am inclined to believe that by forcibly throwing a quantity of carbonic acid, hydrogen, or azote into the vessel by means of a compressing pump, similar to that used for making artificial seltzer water, any change in the substance would be more effectually prevented. No elastic fluid in this case would have room to form by the decomposition of the meat, and the tightness and strength of the vessel would be proved by the process. No putrefaction or fermentation can go on without the generation of elastic fluid, and pressure would probably act with as much efficacy as cold in the preservation of animal or vegetable food."[2]

The use of oil cakes for fertilizing is recommended by Davy, and rape cake and linseed oil are mentioned, although the knowledge that their value depends upon their nitrogenous bodies did not obtain. The fertilizing value of malt dust, which consists of the powdered radicle of malt, is attributed to the amount of sugar which it contains. Linseed cake is said by Davy to be too valuable as a food for cattle to be employed as a manure. Seaweed is also recommended as a valuable fertilizing material. He also dwells upon the value of wood ashes, animal carcasses, and fish for fertilizing purposes. The value of fish is explained by Davy as follows: "It is easy to explain the operation of fish as a manure. The skin is principally gelatine, which, from its slight state of cohesion, is readily soluble in water;

[1] Agricultural Chemistry, p. 274. [2] Ibid., pp. 278 and 279.

fat or oil is always found in fishes, either under the skin or in some of the viscera, and their fibrous matter contains all the essential elements of vegetable substances."[1]

The curious idea that the oil is the chief manurial substance is further advanced in the statement that blubber is a valuable manure. Probably the real value of the blubber was from the minute quantity of nitrogen which it contained.

The value of bones is recognized by Davy. It is stated that "the more divided they are the more powerful are their effects." Bone dust and bone shavings, according to Davy, may be advantageously employed, and he recognizes that the basis of bone is the phosphate of lime, and also that it contains gelatin and cartilage, which seem to be of the same nature as coagulated albumin. It is evident that horn appeared to Davy to be a more powerful manure than bone. The refuse of the slaughterhouses, as skin, leather, hair, feathers, and blood, were regarded as valuable by him.

The value of guano as a fertilizer was also fully recognized at the beginning of the century, a much earlier date than is generally supposed. Davy says that "the value of guano as a fertilizer is easily inferred from its composition. It contains one-fourth part of its weight of uric acid, partly saturated with ammonia and partly with potassa, some phosphoric acid and lime, and small quantities of sulphate and muriate of potassa, and a little fatty matter."[2]

The value of lime for fertilizing purposes is fully discussed by Davy and the principles of its application most justly set forth.[3]

Magnesia was supposed to have almost equal value. The value of gypsum was also thoroughly appreciated. The use of ashes of burned peat was said to be very beneficial.

The value of phosphorus as a plant food was not appreciated, even at the time of Davy, and no large deposits of mineral phosphates were known. In speaking of phosphate of lime, he says: "It exists in some places in these islands native, but only in very small quantities. * * * It is probably necessary to corn crops and other white crops. * * * Bone ashes ground to powder will probably be found useful on arable lands containing much vegetable matter, and may perhaps enable soft peats to produce wheat; but the powdered bone in an uncalcined state is much to be preferred in all cases when it can be procured."[4]

Davy thus unwittingly shows the great loss of fertilizing matter which attends the burning of bones by the destruction of the nitrogenous bodies which they contain, but was not aware that this loss diminished their utility. Speaking of wood ashes, he says: "Wood ashes consist principally of the vegetable alkali united to carbonic

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[1] Agricultural Chemistry, p. 289.
[2] Ibid., p. 297.
[3] Ibid., pp. 315 *et seq.*
[4] Ibid., p. 336.

acid, and as this alkali is found in almost all plants, it is not difficult to conceive that it may form an essential part of their organs."[1]

The vegetable alkali referred to is potash, and its efficiency was supposed to be due to the fact that it rendered soluble carbonaceous and other substances and permitted them to be absorbed by the tubes in the radicle fibers of plants.

In regard to soda, which he calls "mineral alkali,"[2] in distinction from vegetable alkali, he regards it of equal value. The use of common salt is also urged, because it is offensive to insects.

The observations made by Davy on the use of nitrate of potash are extremely interesting. He says: "Sir Kenelm Digby states that he made barley grow very luxuriantly by watering it with a very weak solution of niter; but he is too speculative a writer to awaken confidence in his results. This substance consists of 1 portion of azote, 6 of oxygen, and 1 of potassium, and it is not unlikely that it may furnish azote to form albumen or gluten in those plants that contain them; but the nitrous salts are too valuable for other purposes to be used as manures."[3] This is a very apropos observation, since it was made at the time of the Napoleonic wars.

Sulphate of potassium, Davy says, is considered a valuable manure by Dr. Home. Mr. Naismith questions his results, and quotes experiments hostile to his opinion, and, as he conceives, unfavorable to the efficacy of any saline manure.[3]

In a general view of the whole subject of the use of saline substances, Davy says:

> It is unnecessary to discuss to any greater extent the effects of saline substances on vegetation, except the ammoniacal compounds, or the compounds containing nitric, acetic, and carbonic acid: none of them can afford by their decomposition any of the common principles of vegetation—carbon, hydrogen, and oxygen.
>
> The alkaline sulphates and the earthy muriates are so seldom found in plants, or are found in such minute quantities, that it can never be an object to apply them to the soil. It was stated in the beginning of this lecture that the earthy and alkaline substances seem never to be formed in vegetation, and there is every reason, likewise, to believe that they are never decomposed, for after being absorbed they are found in their ashes.[4]

It is thus seen that as late as 1815 there was no practical appreciation of the use of mineral fertilizers, even in the most advanced studies of the relation of chemistry to agriculture, and the notions regarding the application of vegetable and animal matters for fertilizing purposes were in most cases erroneous and the knowledge of their good effects principally empirical.

KNOWLEDGE OF THE COMPOSITION OF AGRICULTURAL CROPS.

All that was practically known at the beginning of the century in regard to the chemical composition of agricultural products is contained in the third lecture given by Sir Humphry Davy before the

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[1] Agricultural Chemistry, p. 337.
Ibid., p. 337.
[3] Ibid., p. 339.
[4] Ibid., p. 340.

British Board of Agriculture.[1] It will not be necessary, therefore, to give the opinions of other authors on this subject.

Vegetables are thus defined: "Vegetables are living structures distinguished from animals by exhibiting no signs of perception or of voluntary motion; and their organs are either organs of nourishment or of reproduction; organs for the preservation and increase of the individual, or for the multiplication of species."

Nineteen different bodies or classes of bodies were recognized by Davy as constituting vegetable substances in general. These are: "1, gum, or mucilage, and its different modifications; 2, starch; 3, sugar; 4, albumen; 5, gluten; 6, gum elastic; 7, extract; 8, tannin; 9, indigo; 10, narcotic principle; 11, bitter principle; 12, wax; 13, resins; 14, camphor; 15, fixed oils; 16, volatile oils; 17, woody fiber; 18, acids; 19, alkalies, earths, metallic oxides, and saline compounds."

Gum, or mucilage, which is a certain variety of gum, is described as being easily soluble in water and insoluble in alcohol. All the varieties of gum and mucilage were regarded as valuable plant foods, as well as useful in some of the arts, as, for instance, in calico printing.

Starch is described as being soluble in boiling water.

Sugar is regarded as furnished chiefly by the sugar cane, and only small quantities by other sources. It is remarkable that Davy describes a method, which he proposed for purifying raw sugar, which has lately been made the subject of patents in this and other countries, namely, by washing the crystals, or raw sugar, with a sugar sirup. The sugar which is derived from the beet is said to be peculiar in its nature and to agree with the sugar of grapes in its general properties and in having a bitter taste. The properties of sugar, as an animal food, were recognized by Davy, who states that the British market was overstocked with this article from the West India Islands, and for this reason proposals had been made for using it as a food for cattle. His opinion that it was a valuable food for vegetables has already been cited.

Vegetable albumin was known to exist in the juice of the papaw tree, and tables of analyses are given showing its percentage composition.

The properties of gluten are described, and it is said to be distinguished from albumin chiefly by its insolubility in water. Its high nutritive value was also appreciated, and it is stated to be one of the most nutritive of vegetable substances.

Under the head of "extract" is described a variety of substances obtained from different plants, evidently mixtures of various bodies Extract, it is said, in its pure form can not be used as an article of food, but it is probably nutritive when united to starch, mucilage, or sugar.

Tannin is declared to be of no nutritive value.

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[1] Pages 55 *et seq.*

The other bodies found in plants, as enumerated by Davy, are of no value, from a food point of view, except the oils, which he divided into two varieties, namely, fixed and volatile.

Among the acids which were known to exist at that time in the vegetable kingdom, are mentioned oxalic, citric, tartaric, benzoic, acetic, carbonic, and prussic.

Of the fixed alkalies, potash is recognized as being the one common to the vegetable kingdom.

Of the mineral acids, Davy states that phosphoric, sulphuric, muriatic, and nitric exist in many saline compounds in the vegetable kingdom, but they can not be properly considered as vegetable products.

Davy held to the opinion, which was prevalent in his time, and which still exists in many quarters, that the rigidity of plants is due solely to the quantity of silica which they contain. His views of the composition of plants were the most advanced and scientific which had ever at that time been proposed, and their scientific value especially may be recognized by a comparison with the theory of plant composition exposed by Dr. Thomson in his elaborate and learned system of chemistry. He quotes Thomson as describing six vegetable substances, which he calls mucus, jelly, sarcocol, asparagin, inulin, and ulmin. Davy does not agree with this view, and says: "It is probable, from the taste of sarcocol, that it is gum combined with a little sugar. Inulin is so analogous to starch that it is probably a variety of that principle; ulmin has been lately shown by Mr. Smithson to be a compound of a peculiar extractive matter and potassa; and asparagin is probably a similar combination."[1]

It is not to be wondered at that the views, even of the most advanced kind, concerning the composition of plants were of such an erroneous nature when we consider the state of analytical chemistry at that time. Sir Humphry Davy was, without doubt, the most skillful and accurate chemist of his time or of any time that preceded him, and the wonder is that he could have reached such correct results with the methods of analysis which he himself describes.

In regard to the theoretical composition of bodies resembling each other in vegetable substances, Davy says:

> Gum and sugar afford nearly the same elements by analysis, and starch differs from them only in containing a little more carbon. The peculiar properties of gum and sugar must depend chiefly upon the different arrangement or degree of condensation of their elements; and it would be natural to conceive from the composition of these bodies, as well as that of starch, that all three would be easily convertible one into the other, which is actually the case.
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> At the time of the ripening of corn the saccharine matter in the grain and that carried from the sap vessels into the grain, becomes coagulated and forms starch; and in the process of malting, the converse change occurs. The starch of grain

[1] Third lecture by Sir Humphry Davy before the British Board of Agriculture, p. 118.

is converted into sugar. As there is a little absorption of oxygen and a formation of carbonic acid in this case, it is probable that the starch loses a little carbon, which combines with the oxygen to form carbonic acid; and probably the oxygen tends to acidify the gluten of the grain, and thus breaks down the texture of the starch, gives a new arrangement to its elements, and renders it soluble in water.[1]

The first table showing the comparative nutritive value of different foods ever published was probably that constructed by Davy, in which all the more common vegetable varieties of foods are compared in respect of their proportions of nutritive matter. These nutritive bodies are grouped under four heads—mucilage, or starch; saccharin matter, or sugar; gluten, or albumin; and extract. Rather strangely, the oils and fats of vegetables are not regarded as of sufficient nutritive importance to find a place in the table.

The value of gluten in bread making is fully recognized in Davy's studies of the composition of plants, and some of the earliest observations upon the nutritive value of different kinds of wheat are found in his writings. He says:

> It is probable that the excellence of the different articles as food will be found to be in a great measure proportional to the quantities of soluble or nutritive matters they afford; but still these quantities can not be regarded as absolutely denoting their value. Albuminous or glutinous matters have the characters of animal substances; sugar is more nourishing, and extractive matter less nourishing, than any other principles composed of carbon, hydrogen, and oxygen. Certain combinations likewise of these substances may be more nutritive than others.[2]

It was also recognized that flour made from hard wheat is to be more esteemed than that made from soft, even when there is no difference in the process of making them into bread; but the flour from hard wheat will absorb and retain more water in making into bread, and will consequently produce a greater weight of bread. It is shown by chemical analysis that this difference in incorporating hard and soft wheat in bread making is due to the larger amount of gluten contained in the hard wheat.

REVIEW OF THE EARLY KNOWLEDGE OF THE RELATION OF CHEMISTRY TO AGRICULTURE.

It is now possible to give a general view of the knowledge of the relations which chemistry held to practical agriculture at the beginning of the century. In regard to soils, some general notions of a true character were held as to their composition. The real plant foods in the soil, however, were not appreciated. While in a general way it was recognized that phosphoric acid, potash, and lime entered into the composition of the plant, it is evident from a study of the literature of the time that silica was regarded as more beneficial to the plant than any of the other mineral matters mentioned. The manner in which the food was furnished to the plant was imperfectly

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[1] Third lecture by Sir Humphry Davy before the British Board of Agriculture, pp. 127 and 128.

[2] Ibid., p. 151.

known, save that it was generally conceded that the mineral matters must first enter into solution before they could be distributed throughout the plant.

In regard to the physical nature of the soil, it was a matter of common observation that it had much to do with the efficacy of plant growth. The open and porous soils were more prized than those of a hard and impenetrable nature, and the general distinctions between sandy, loamy, and clayey soils were well understood.

The notion was extremely prevalent that the soils serve more as a resting place and support for the root system of the plants, while the materials for plant growth in some way resemble exudations, or emanations, which come partly from the soil itself and partly from the atmosphere. The actual chemical composition of soil was but little understood, and this arose from the fact that the means of chemical analysis were so meager and its processes so unsatisfactory as to preclude the possibility of securing exact data. Nevertheless, a reasonably accurate knowledge was had of the chief constituents of the soil, if not of the functions which they played in plant growth. That the soil was a vehicle for the administration of the nourishing elements of food, was not fully appreciated at the beginning of the century. The nitrogen, or azote, as it was called in that day, was supposed to reach the plant exclusively in the form of ammonia, and no accurate knowledge of the relation of the soil to the production of azotized foods was extant.

Perhaps, however, the most striking error in connection with the notions relating to the constitution of the soil itself in respect of plant growth is found in the fact that the true functions of phosphoric acid and potash in the nutrition of plants were imperfectly, if at all, understood by even the most advanced agricultural chemists of that day.

It is true that the chemical composition of manures which were then in use was not well known, nor were the processes by which manures became available as plant food at all understood, but the practical knowledge of the use of stable manures, of marls, of gypsum, and of lime was generally diffused and acted upon. Of artificial manures, other than those mentioned, little was known save that the aborigines of the New England States had taught the early settlers the great value of using fish as a fertilizer.

Some idea also was entertained of the value of the refuse of the slaughterhouses for fertilizing purposes, and it was known that blood, bone, and horn were useful in promoting the growth of crops, but how and why were not understood.

The value of clover and other leguminous crops in increasing soil fertility was recognized, but the causes which established this value were not at all known. The process of fermentation was recognized in the manufacture and preparation of manures, but the nature of this fermentation was wholly unknown to the investigators and chemical agriculturists of that time. Empiricism in the use of manures through thousands of years had led to most valuable practical results, but little was due at that time to the discoveries and researches of chemistry. When we look at the knowledge which was possessed of the composition of plants, we do not wonder that the relations of the soil and of fertilizers to plant growth were so little understood. The methods of investigation in vogue were totally inadequate to reveal the true constitution of plants, and it is a matter of wonder to us at the present time that with such crude apparatus and such imperfect methods so much accurate knowledge could have been obtained. The processes of organic analysis had only just been introduced, and only the general constitution of the carbohydrates, as represented by the gums, mucilages, starches, and sugars of that day, was definitely established, but the percentage of nitrogen contained in the albumin and gluten recognized as existing in plants is scarcely more accurately known at the present day than it was then.

The more important organic acids also existing in plants had been discovered, separated, and identified, and in general it must be confessed that, in so far as the progress of chemistry relating to the composition of plants is concerned, the agricultural chemists of the beginning of the century are to be congratulated on the attainments which they had made. The weak point of their researches and investigations was that they had made no systematic effort to correlate the composition of plants and of the soil to the principles of plant growth. With their imperfect ideas of the nature of plant nutrition, it did not occur to them that a great system of scientific agriculture could be based upon investigations of this kind. They, however, had done enough to pave the way for the great impetus which the investigations of Liebig, Gilbert, Boussingault, and others gave to systematic agricultural chemistry some thirty or forty years later.

Scientific Agriculture About the Middle of the Century.

THE ERA OF LIEBIG.

The publication of Liebig's work entitled "Chemistry in its applications to agriculture and physiology," in 1840, marked a complete change in the theories of chemistry in respect of agriculture existing at the beginning of the century as portrayed in preceding pages, and inaugurated the new science of agriculture, resting upon his investigations as a foundation. If Wurtz could say, "Chemistry is a French science, founded by Lavoisier, of immortal memory," with all the greater propriety may we say of the agriculture of to-day, "Agriculture is a chemical science, founded by Liebig, of immortal memory." "Perfect agriculture," Liebig says in the preface to the first edition of his book, "is the true foundation of all trade and industry; but a rational system of agriculture can not be formed without the application of scientific principles, for such a system must be based on an exact acquaintance with the means of nutrition of vegetables and with the influence of soils and actions of manure upon them; this knowledge we must seek from chemistry, which teaches the mode of investigating the composition and of studying the character of the different substances from which plants derive their nourishment."

Within a year after Liebig's book was published it was translated into English, and soon thereafter was found in the languages of all the leading nations of the world. Liebig, however, must not be given the sole praise for the establishment of the true theory of scientific agriculture. Very much earlier in the century De Saussure, a celebrated French chemist and botanist, published his "Chemical researches on vegetation," and a decade before Liebig published his first work Boussingault, the most celebrated French agricultural chemist of the early part of the century, had produced a great many works on the relations of chemistry to agriculture. To both of these authors Liebig is largely indebted, and to each of them he gives full credit. The part which Davy took in preparing the way for these later investigations has already been pointed out.

Previous to the time of Liebig, as already indicated, it was commonly understood that organic substances, such as sugars and oils, were the chief foods of plants, either in the fresh state or in the partially decayed condition known as humus. In fact, the attitude of chemistry toward agriculture in the first four decades of the century was so strongly marked on this point that the whole system of plant nutrition, as understood at that time, might with propriety be designated the humus theory. Although other writers before the time of Liebig had intimated that the air and water, and not the earth, were the source of the carbon, oxygen, and hydrogen in plants, it must be admitted that it was through the researches of Liebig that the great principles of plant nutrition, founded on the elaboration of the elements of carbohydrates from the air and water, were fully developed. As in most other instances, however, the tendency of mankind to reach extremes was shown on this point. Liebig in his fight against the humus theory naturally went to the other extreme of denying that the humus took any part at all in plant nutrition. He based his chief objection to the humus theory on the ground that humus was practically insoluble, and that therefore it could not enter into the circulation of the plants. This argument we know now is not a valid one, but it served as the basis of an attack upon an erroneous theory which had established itself firmly in the minds of advanced agriculturists.

As early as 1807 Thompson observed that if plants be deprived of carbonic acid, they wither and die, and these observations had been confirmed by a great many observers. It was Ingenhousz who first made the observation that plants absorb carbonic acid only under the influence of sunlight, while in darkness the tendency of plants is to give off rather than absorb this gas. It was urged against Liebig's theory of plants deriving their carbon from carbonic acid that the quantity of this gas in the air was so minute as to render Liebig's idea absurd. It is well known at the present time that the amount of carbonic acid in the air does not much exceed 4 parts in 10,000, and yet this quantity is amply sufficient to furnish the immense quantities of carbon of which the structures of plants are largely composed. It is easy to believe that in past ages, especially the one known by geologists as the Carboniferous Era, the quantities of carbonic acid in the air were much larger than at the present time and the amount of precipitation much greater. These two conditions, combined with the fact that the temperature of the earth must have been higher, account for the luxuriant growth of vegetable matters in those epochs, the gradual decay of which, under pressure, has provided the coal deposits of the present day. Liebig and his colaborers finally determined experimentally that organic matters were not suitable foods for plants, and that when sugar, gum, or starch are offered to a plant these compounds do not nourish it in any true sense. The vital functions of plant life consist rather in the elaboration of these organic bodies and other compounds from the inorganic elements on which the plants are fed. This is true, especially of green plants; whereas in the case of colorless plants the reverse is probably true, and these feed rather upon organic matter than upon inorganic. It was in this instance that Liebig's theory led him too far in denying the part of organic matter in any kind of plant life. Indeed, it has been found by researches carried on in the Division of Chemistry that the elements of humus may enter into the plant, as shown by the dark color of the juices of sugar cane grown upon humus soils and in the increase of amid nitrogenous matter in oats grown upon soils extremely rich in humus.

Long after the establishment of the practical truth of the doctrines of Liebig it was discovered that Lavoisier, fully sixty years before the time of Liebig's discoveries, had observed the same phenomena, although the information was not given to the public until the final publication of the papers of the great French chemist in 1862. It was then discovered that in one of Lavoisier's notes he had made this pregnant observation: "Plants derive the materials necessary for their formation from the air which surrounds them, from the water, and in general from the mineral kingdom." Thus, after all, we must attribute to Lavoisier the credit of having discovered the true theory of plant nutrition. The following from Lavoisier's observations wonderfully increases our admiration for the genius of this great man:

> Animals feed on plants and on other animals fed by plants, so that the substances composing them are, in the last instance, always drawn from air and from the mineral kingdom. On the other hand, fermentation, putrefaction, and combustion continually restore to the air and to the mineral kingdom the principles borrowed from them by plants and animals.

While the theory of Liebig touching the formation of carbohydrates is fully corroborated by all modern investigations, in so far as the food of green plants is concerned, he never obtained the true solution of the method in which nitrogen was fed to plants. He assumed that the nitrogen was fed in the form of ammonia produced by the putrefaction of plants and animals, and, as is now well known, formed in the atmosphere by electrical discharges and in other ways. Liebig, as appears from his researches, was not at first aware of the importance of the part played by artificial fertilizers and manures in furnishing nitrogen to plants.

MINERAL THEORY OF PLANT NUTRITION.

The advances which chemistry has made in establishing the methods by which nitrogen becomes food for plants will be shown later. While the older view of the nutrition of plants is properly characterized by the term "humus," or "organic," theory, the school established by Liebig held to the theory of plant nutrition which may properly be denominated the "mineral" theory. Liebig was the first to study systematically the subject of mineral or artificial manures, and his views in this matter soon found their way into the United States. In the agricultural part of the Patent Office Report for the year 1845 Liebig contributes an interesting letter on the subject of artificial manures. In this letter it is believed the true principles connected with artificial manuring were first brought to the attention of American farmers. Among the artificial manures mentioned by Liebig in this letter are the earthy phosphates, of which at that time practically only one variety, namely, apatite, was known to exist. Liebig, however, in discussing the value of phosphate of lime as a fertilizer makes the curious mistake of saying that bones are most efficient for fertilizing purposes after they have been burned. It is strange that so keen an observer as Liebig could have been led into such a great error. He was right, however, in assuming that so far as the phosphate of lime is concerned, its utility as a plant food is determined largely by the rapidity with which it will enter into solution. It was for this reason that he assumed that the burned bones were more efficient than the unburned, arguing with great skill that the gelatin, or glue, which the bones contained had a tendency to keep the phosphatic material insoluble. He was the first who recommended the use of sulphuric acid on bones and mineral phosphates for the purpose of converting the lime into gypsum and securing the phosphoric acid in a state more easily soluble and assimilable. He also recommended the alkaline phosphates, such as those of soda and potash, as being excellent fertilizing substances on account of their high solubility. He recognized that the alkalies, namely, potash and soda, should be constituents of every rationally composed manure, since by them the original fertile condition of the fields is preserved. He observed that the soil which contains alkalies in too small a quantity may be fertile for grain, but not necessarily so for turnips or potatoes, which require a great quantity of alkali. Sulphate of potash, common salt, and chlorid of potash were regarded as valuable manures, and the latter was said to be found in milk in large proportions.

Gypsum is recommended as a nourishment for leguminous plants. In speaking of the salts of ammonia, Liebig says it is certain that the azote, or nitrogen, of the plants is derived from the ammonia of the atmosphere or from a manure which is provided in the shape of animal fluid and solid excrement, and, further, that nitrogenous bodies are only useful in plant nutrition in proportion as they give up their nitrogen in the form of ammonia. In regard to decaying vegetable matters, he regarded them as useful only in so far as by their decay they afforded carbonic acid, but says that they are not indispensable in manure. As before mentioned, Liebig rather inclined to the extreme view in this case, denying to humus matters any proper place in plant nutrition. He fortifies the observations made by citing analyses of the ashes of some common crops, such as beans, peas, potatoes, clover, and hay. He also deduces the conclusion from these analyses that for stalks and leaves, manurial elements are required other than for seeds. The stalks and leaves contain no alkaline phosphates, but they require a rich supply of alkaline carbonates and sulphates. On the other hand, the carbonates are entirely wanting in the seeds, but the latter are very rich in phosphates. It is rather curious that Liebig should have fallen into the error of supposing that the carbonates in the ash existed in this state in the plants themselves; that he did not know that the occurrence of carbonates in the ash of the leaves and their nonoccurrence in the ash of the seeds are due solely to the presence of peculiar constituents of each, which permit a formation of carbonates on combustion in the ash of the leaves and prevent its formation in the ash of seeds on account of the excess of phosphoric acid, which at a high temperature completely expels carbonic acid from combination. In his letter to American farmers he calls particular attention to the fact that a manure which furnishes only one constituent element of plant food may rapidly exhaust the soil of all the other elements of fertility, and hence the necessity of supplying complete fertilizers instead of partial ones where the fertility of the soil is to be preserved or increased. He ascribes the fact that guanos have not always met the expectation of those who have used them to the presence in them of ammonia and alkaline phosphates and the practical absence of alkalies. He therefore urged particularly that fertilizers containing large quantities of potash and soda be used in conjunction with guanos in order to secure the best effects. In this letter Liebig also calls attention to the loss of the soluble elements of manure by lixiviation in the soil, and for this reason recommends that the manure of the barnyards be preserved, either in pits from which the water can not escape or in covered sheds, to prevent the exhaustion of their soluble fertilizing ingredients. He says:

> The reason why in certain years the influence of the best and most plentiful manuring is scarcely perceptible is that during the moist and rainy springs and summers the phosphates and other salts with alkaline bases, as also the soluble ammoniacal salts, are entirely or partly removed. Art must find out the means of reducing the solubility of the manuring substances to a certain limit; in a word, of bringing them into the same state in which they exist in a most fertile virgin soil, and in which they can best be assimilated by plants.

Looking forward, too, with a prophetic eye, Liebig saw a great industry which would grow out of his researches in the establishment of factories where artificial manures would be prepared for agricultural uses. He says at the close of his letter:

> Manufactories of manure will be established in which the farmer can obtain the most efficacious manure for all varieties of soils and plants. Then no artificial manure will be sold whose exact amount of efficacious elements is not known, and this amount will be the scale for determining its value. Instead of the uncertainty of mere empiricism, all the operations of agriculture will be carried on with certainty, and instead of awaiting the results of our labors with anxiety and doubt, our minds will be filled with patience and confidence.

In reading over this admirable letter, contributed by request of the Commissioner of Patents to the American farmers by Professor Liebig, we are struck with the fact that fifty-five years ago the farmers of this country were provided with a creed for judging fertilizing materials which has undergone but little change as the result of all the researches which have been made since that time. It is hardly to be expected that even Liebig at that day would have correctly appreciated all the problems connected with fertilizing processes. The great principles, however, which underlie the application of artificial fertilizers were fully set forth, and the publication of this information to American farmers is therefore justly considered an epoch in the relations of chemistry to agriculture in the United States.

Although the views of Liebig were first promulgated in 1840, and, as indicated, were placed before the farmers of America as early as 1845, we find that as late as 1848 grave doubts of their accuracy were still entertained by those in charge of the Agricultural Division of the Patent Office. In the report for 1848 there is a long article, beginning on page 195, in which the views of Liebig are vigorously combated by references to authorities of his own country, chiefly von Thaer and Schulze. Sir Humphry Davy is held up in this discussion as an authority of greater value than Liebig. Considerable space is given to showing that it is quite improbable that the air, however rapidly it may move, can furnish enough carbon for the use of the plants; and Professor Schleiden, in his criticism of Liebig's theory, says: "Must we here adopt the ignorance of physics, or a wholly thoughtless insertion of it, as a cause of this monster of the wind theory?" It is concluded from a very elaborate study of the various theories relating to the nutrition of plants that Liebig's theory is liable to some fundamental objections, and the question is raised whether the humus theory, of which von Thaer was the chief apostle, supported, however, by the eminent authority of Professor Schulze, could be maintained against the objections which Liebig had urged to it. The Commissioner of Patents adds:

> It may be thought by some we have devoted too much time and space to this subject, but Liebig's works have been so extensively diffused in this country and in their charm of style and the enthusiasm with which the author entered into his discussions, the boldness displayed in his enunciation of his novelties, and other concurrent causes, they have exerted so great an influence in various sections that these facts seemed to justify the attempt to present, in as condensed a form as we could with any justice to the author, one of the ablest criticisms to which his principles have been subjected. Having in former reports presented the history of Liebig's views, we may claim the right of giving, too, the other side of the question, and the more so since a right discrimination of the points is contained in the foregoing synopsis of Professor Schulze's elaborate criticism.

It is evident, therefore, that even at this time, almost the middle of the century, the view was still stoutly maintained by eminent men that the organic matters of which plants are composed were derived chiefly from the soil, and not from the atmosphere and water. Hence it was, that with wonderful pertinacity the agricultural chemists clung to the theory that the organic matters of plants were directly derived from the decaying organic matters of the soil, and that therefore humus was the chief element in the nourishment of plants. (Pls. IV and V show portraits of some of the early and of the more recent workers in agricultural chemistry mentioned in this paper.)

Relations of Chemistry to Agriculture at the Present Time.

METHODS BY WHICH RESULTS OF CHEMICAL STUDIES HAVE BEEN MADE OF PRACTICAL USE.

Among the methods which have been chiefly instrumental in bringing the results of chemical research into practical use in agriculture at the present time may be mentioned the following:

(1) The teaching of agriculture in schools, colleges, and universities, and instruction given in farmers' meetings.

(2) The activity of agricultural colleges and experiment stations.

(3) Instruction in the relations of chemistry to agriculture given in the agricultural press.

TEACHING OF AGRICULTURE IN SCHOOLS, COLLEGES, UNIVERSITIES, ETC.

It is rather difficult in discussing the first of these subjects to determine when the first instruction was given in schools, colleges, or universities in regard to the relations of chemistry to agricultural science. The first professorship evidently established for this purpose was founded at the University of Halle in 1727, when Frederick William, King of Prussia, established a professorship of rural economy,

SOME EARLY WORKERS IN AGRICULTURAL CHEMISTRY.

in which the relations of chemistry to agriculture, as then understood, were developed and taught. The order in which similar chairs were established in other universities is hard to say, but in 1800 it is certain that other universities in Europe had followed the example of that of Halle.[1]

The importance of agricultural education was early recognized in the United States, as is seen in the Agricultural Reports of the Patent Office. In the report for the year 1847 a special plea is made for the establishment of agricultural education in the United States, as follows:

> We might remark on the application of chemistry, animal and vegetable physiology, geology, and other sciences, with domestic economy, in reference to this great question of progress and as elements not without their bearing on the development of our agricultural resources. But these topics may be better touched upon in another part of this report, where we may treat of modes of cultivation and feeding of animals, with kindred topics.
>
> There is one particular, however, which seems to claim our notice. This is *agricultural education:* a new era seems, in this respect, to be opening upon us. It may take years before we shall have our Hohenheims, Schlicsheims, Tharands, and Moeglins, as in Germany and Prussia, but a beginning is made by attempts to establish such schools and colleges. There have been a number of the former set in operation by private enterprise, and in several of our colleges professors have been appointed who are well qualified to lecture on these subjects. In the time-honored universities of Harvard and Yale, two gentlemen who have enjoyed ample opportunities of pursuing their studies in Europe fill the chairs of the professorships. A man of experience also in science has recently been placed in this department in one of the colleges of Ohio. Much may be expected from the influence of these and similar positions in relation to this important subject; and here, too, we may refer our readers to the account given of agricultural education as well as of the agricultural convention at Breslau, by C. L. Fleischmann, esq. This account, with other articles of deep interest to the agriculturist of the United States, may be found in Appendix No. 1.

It is thus seen that more than half a century ago several agricultural schools, pure and simple, were established in Europe, and that at least two of the leading universities of this country, namely, Harvard and Yale, had established chairs of agricultural chemistry.

In the same report it is urged that traveling lecturers could diffuse agricultural knowledge, and the custom of the farmers' clubs and agricultural colleges of Great Britain in bringing together distinguished scientific men to give their views upon some topic selected as the subject of discussion is mentioned with favor. It is stated that the lectures of this kind indicate the principles of the application of manures, and deal with many other questions in which a knowledge of chemistry plays an important part.

In the article of Mr. Fleischmann, in the same report, on the agricultural schools of Germany, an account is given of his visit to one of the earliest and most famous of these schools, namely, that founded

[1] Rural Socrates, p. 15.

and conducted by von Thaer. In this school Dr. Trommer, a celebrated chemist of his time, was employed as a lecturer on chemistry and physical philosophy with reference to their employment in agricultural industry. On page 319 of the report it is stated that the lectures of Dr. Trommer were especially devoted to agricultural chemistry, illustrated by experiments required for a clear insight of the same, with constant regard to the use of these sciences in agriculture and the business therewith connected, such as breweries and distilleries, sirup and sugar making from beets and potatoes, and other matters of a technical nature relating to agriculture. Besides this, the student was given an opportunity of performing simple chemical analyses under a superintendent. There was also taught the outline of the physiology of plants, thus enabling the educated agriculturist to penetrate deeper into the science and to secure a clearer insight into vegetation.

Thus early it is seen that agricultural chemical technics, and the principles upon which they are based, were made a principal part of the instruction given in agricultural schools to the young man engaged in acquiring a knowledge of agricultural science.

Space will not allow the tracing of the evolution of agricultural education step by step, and so we must pass over the early history and proceed to the consideration of the practical foundation of such education in the United States.

The first endowment for teaching agriculture in the United States was provided for Harvard University in 1837 by the will of Benjamin Bussey, and for Yale in 1846, and the first instruction in agricultural science from a chemical point of view was given at Yale in 1847. Since that time chairs of agricultural chemistry have been regularly established and maintained in these institutions.

RÔLE OF CHEMISTRY IN THE AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

In a study of the impress which chemical research has made upon agriculture, there has been no factor during the past twenty years which can compare with the work of the agricultural experiment stations of the United States. Richly endowed as they are by the General Government, they have had every opportunity to secure the best results for practical agriculture.

In this work chemical science has played a very important part in the furthering of agricultural prosperity. Of the forty-nine directors of the stations at the present time, twenty were professional chemists at the time of their appointment. The selection of so many professional chemists was no mere chance, but evidently had some relation to the dominant position which the science of chemistry held to the promotion of agricultural chemical research. The list of directors of the agricultural experiment stations of Germany shows the same condition of affairs.

The great influence of chemistry on the agricultural experiment stations of this country is not measured alone by the number of professional chemists which is found in the directorates, but also in a comparison of this number to that of other scientific men holding similar positions. Very few of the other sciences are represented among the directors of stations, and no one of them can compare in its number of representatives to the science of chemistry. Among the working forces of the stations chemists also predominate. There are twice as many chemists employed in the stations as there are men engaged in any other professional scientific work. Statistics show that the number of chemists employed in the agricultural experiment stations of the United States is one hundred and fifty-seven, while the number of botanists is fifty and the number of entomologists forty-two. The number of employees belonging to other branches of science is very much less than that of the botanists and entomologists, and the total number of scientific men employed in all other branches of scientific work in the stations does not greatly exceed, even if it be equal to, the number of those employed in chemical research alone.

While dwelling upon the predominance of professional chemists in the directorate and upon the staff of the experiment stations it seems eminently proper to mention here in a special manner some of the earlier eminent chemists who have contributed so much to the value of chemical research in our agricultural colleges and experiment stations. Among these must be mentioned Prof. F. H. Storer, of Bussey Institute (Massachusetts), who first began the regular publication of a bulletin recording the work of the school and station, which has "set the step to which the bulletins from many other stations are still marching." The bulletins of the Bussey Institute describing original research work on agricultural subjects have proved of the highest benefit to agriculture. Professor Storer's work entitled "Chemistry in some of its relations to agriculture," the first edition of which was published in 1887, has had a marked effect upon agriculture in this country.

As early as 1846 Yale University, then called Yale College, appointed a professor of agricultural chemistry. This was John Pitkin Norton, who had devoted himself to the study of scientific agriculture both in this country and Europe, especially with the celebrated Liebig. He brought to his position a ripe knowledge and wisely directed enthusiasm for agriculture, which he used with the greatest profit in its service. In 1855 Samuel William Johnson was appointed instructor in agricultural and analytical chemistry, and soon after full professor. Perhaps no one ever succeeded more fully in popularizing scientific agriculture than Professor Johnson. His two books, "How plants feed" and "How plants grow," the first editions of which were published in 1868 and 1870, respectively, have been kept abreast of modern progress in successive editions, and are still used as standard text-books and as authorities on the practical relations of chemistry to agriculture.

In the University of California the work of Prof. E. W. Hilgard must be mentioned as being of fundamental importance in the development of the relation of chemistry to agriculture in this country. Professor Hilgard in his classical work on soils has placed himself in the front rank of investigators on this subject, not only in this country but in the world, and his achievements have been recognized both by his countrymen and by the most celebrated societies of Europe. A knowledge of the soil and its relations to plant growth constitutes one of the fundamental principles of chemistry, and the researches of Professor Hilgard in this line have done much to place agriculture in the United States on a strictly scientific basis.

At Cornell, even before her doors were open to students, a professorship in agricultural chemistry was established. Prof. G. C. Caldwell was appointed to fill this position, and he has done so with distinction to himself and the university, and with the greatest benefit to agriculture. One of the most important services in connection with Professor Caldwell's labors at Cornell has been the publication of his work on agricultural chemical analysis in 1869. At that time no work of a similar nature existed in the English language, and Professor Caldwell's book was a veritable boon to students in agricultural science.

This brief reference to the contributions of some of the earlier workers in agricultural chemical science in this country would not be complete without mention of the labors of Prof. C. A. Goessmann, of the Massachusetts Agricultural College.

It is not possible in the space assigned to this paper to even name the more prominent later workers.

A national epoch in agricultural education in this country began with the passage of the Morrill Act, in 1862, establishing and endowing colleges where agriculture should be one of the principal branches in which instruction is given. An additional impetus was given to this great work in 1887 by the passage of the Hatch Act, establishing agricultural experiment stations in the several States. The organization lists of the agricultural colleges and experiment stations of the United States now show the great number of men working in the lines of agricultural chemistry. This most remarkable evolution of agricultural education has taken place practically within the last thirty years, and there is no country which can now be compared with the United States in the munificence of the endowment for agricultural chemical research or in the vast amount of research and experimental work conducted in these lines.

DISSEMINATION OF THE PRINCIPLES OF AGRICULTURAL CHEMISTRY THROUGH THE AGRICULTURAL PRESS.

One of the important channels through which the principles of agricultural chemistry have been disseminated throughout the United States has been the agricultural journals. In no other country has the agricultural press obtained so firm a hold and exercised such an authority as in this country. Early in the century agricultural journals were established, many of which are still in existence. In 1845 it is stated in the agricultural report for that year that there were twenty-six journals in the United States devoted exclusively to agriculture. Of these, eight were weekly, sixteen monthly, one quarterly, and one unclassified. Among those which are still in existence, and which were mentioned at that time, may be cited the Maine Farmer, the Boston Cultivator, the Massachusetts Ploughman, the American Agriculturist, the American Farmer, the Indiana Farmer, the Prairie Farmer, and perhaps a few others. A list of the agricultural journals of the present time would show a wonderful increase in number. In addition to the purely agricultural journals, a great many of the newspapers of the country have agricultural departments which, at least once a week, convey to the farmer important information in regard to scientific agriculture. It is evident, therefore, that many of the beneficial effects of chemical research relating to agriculture have found their application through the columns of the journals mentioned.

PROMOTION OF SCIENTIFIC AGRICULTURE BY THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS.

It is evident that one of the most important ways in which chemistry can promote the interests of agriculture is by furnishing reliable and accurate means of studying soils, agricultural products, and other bodies connected with the interests of farming. If researches of this kind are not made in a uniform way, they can not be compared among themselves, and if they are not made by accurate methods may lead to erroneous results. The full benefit of chemical research, therefore, on agricultural progress can only be secured when the methods of investigation employed are uniform and accurate. The condition of the methods of agricultural research in the United States up to within twenty years was not satisfactory. With the exception of the book by Professor Caldwell on "Agricultural chemical analysis," no distinctively American work had been done along these lines. To Professor Caldwell, scientific agriculture owes a great debt for being the first in this country to attempt to systematize the methods of chemical research as applied to agriculture. Nevertheless, this work had no official authority, and chemists engaged in agricultural research could use the methods described by Professor Caldwell or not, as they saw fit. The first steps toward correcting this condition of affairs were taken by the department of agriculture of the State of Georgia. Mr. H. J. Redding, now director of the experiment station of that State, induced Hon. J. T. Henderson, commissioner of agriculture of Georgia, to call a meeting of chemists interested in agricultural research, which was held in Washington City, at the Department of Agriculture, beginning July 28, 1880. This initial meeting, after making important advances, adjourned to meet in connection with the American Association for the Advancement of Science in August of the same year. An organization was perfected at this time, and it was again decided to meet with the American association in August, 1881, at Cincinnati.

Methods of analysis were agreed upon at these meetings, which, however, still lacked any official authority, as no permanent official organization had been effected. After the Cincinnati meeting no efforts were made to continue the meetings of the new organization, and it was felt that the personnel of the meetings had been of such a character as to render impracticable a harmonizing of the different conflicting elements represented. No further attempts, therefore, were made to coordinate the work of agricultural analysis until 1884, when a meeting of chemists connected with official agricultural work was held in May, at Atlanta, Ga. Here a strong organization was effected, and the meeting adjourned to Philadelphia in September. At the September meeting the organization of Official Agricultural Chemists was completed, admitting to full membership in the society all persons officially connected with agricultural research of a chemical nature throughout the United States, and to limited membership other chemists interested in agriculture having no official position. The constitution of the association provided that all methods of analysis which were adopted as official, and thus made binding upon its members, should be acted upon only by the votes of those who had official connection with chemical work, under government, either national or State. Since September, 1884, the Association of Official Agricultural Chemists has held annual meetings, mostly in Washington City, and, as a result, methods of research have been perfected and adopted which are made binding upon the members, and which have been recognized by the courts of the country as official in every respect. These methods of research have become so perfect and so effective that they have recognition in all countries, and the work of the association is everywhere recognized as being of the highest order and as having secured the greatest good. At the present time the official methods of investigation include not only the study of soils, of fertilizers, and of agricultural products, but special methods have been adopted for the study of human and animal foods, of dairy products, of different fertilizing elements, of manures and fertilizers in general, of carbohydrates and nitrogenous bodies, of tanning materials, and of insecticides.

The association has not contented itself with the mere study of analytical detail, but has instituted lines of research having for their object the elucidation of unsolved problems in agriculture and the application of the results to practical work. The direct practical benefit of the work of this association has been found in the establishment of efficient fertilizer control in nearly all of the States of the Union. By means of this official control the farmers are protected in the character of the fertilizing materials which they buy. These materials are inspected by the State authorities, and can only be sold when their composition comes up to the standard set by these authorities. The economical value of this control alone is only to be measured by millions of dollars. The association has published the results of its labors in numerous bulletins under the patronage of the Secretary of Agriculture and issued from the Division of Chemistry. These bulletins contain not only the proceedings of the association, with all the discussions relating to problems in practical agriculture, but also recommendations as to methods of research to be followed by chemists throughout the country, whether having relation to agricultural research or not. One of the most important of the works which has been undertaken, and which is now partially completed, has been in determining the standards of purity for food. The work of the Division of Chemistry in respect to food adulteration is described further on. In order, however, that a competent control of food adulteration may be exercised, it is necessary that the judicial authorities have reliable standards to which reference can be made in legal proceedings. It is evident that such standards can only be secured by the comparison of a vast amount of chemical data and an institution of the most careful research. The Association of Official Agricultural Chemists has taken up this subject in a systematic manner, and the various problems relating to the standards of pure food are placed in the hands of special committees, who have already accomplished a great part of the work which has been assigned to them. At the completion of the work it will be possible to present for the approval of Congress, and of the various legislative bodies of the country, a system of food standards, just and correct, based upon the widest knowledge and the most careful research. With the aid of these standards the enforcement of pure-food laws will be made easy and the punishment of those who violate their provisions rendered certain. The proceedings of the association and the methods of analysis and research adopted by them are found in the bulletins issued from the Division of Chemistry.

CHEMISTRY IN AGRICULTURAL REPORTS OF THE PATENT OFFICE, ETC.

NUTRITION.

The first work of agricultural chemistry was naturally to develop the principles upon which plant nutrition is based. It was soon seen, however, that animal nutrition rests upon the same general principles, and that the same methods of research, with the necessary modifications for the changed environment, are to be used in both cases. Thus early the aid of chemistry was invoked in establishing the true principles of animal feeding. But little was known of a positive nature in this matter in the early parts of the century. Toward the middle of the century, however, considerable contributions had been made by agricultural chemists to this subject. The Agricultural Reports of the Patent Office in early years contained articles on this subject. In the report for 1849 several pages are given to the discussion of the nutritive value of foods. The comparative value of the whole flour of wheat as compared with the fine flour is also given, and the contributions of Peligot, the celebrated French physiological chemist, are freely referred to. An interesting chapter is also contributed on the nutritious properties of various other articles of food, and the chemical methods which were in vogue for determining the composition of wheat flour and of ascertaining its nutritive value are set forth in some detail. The work of the Department of Agriculture in regard to the principles of nutrition has been prosecuted with more or less vigor by chemists connected with its service from the middle of the century to the present time. In the agricultural experiment stations also the principles of animal feeding have been fully developed by practical work. The general principles of animal nutrition were made available for farmers' use at an early day by the publication of Armsby's "Manual of cattle feeding," in the year 1880. Although this was essentially a translation of a foreign work, yet in its publication various improvements and additions were made by the author and translator, which rendered the book far more valuable than the original work. Among the later publications on the same subject may be mentioned the work of Professor Henry, published in 1898. In addition to this, various bulletins from the Division of Chemistry and from the Office of Experiment Stations of the Department of Agriculture have been issued from time to time on the subject of nutrition and on the composition and nutritive value of foods in general.

As the result of all these investigations the practical farmers of the country have now at their command, and in forms which they can fully understand, the great principles of animal nutrition. It is certain that the actual cost of the food required for placing an animal upon the market for meat or in preparing it for work has been very much diminished. Even if no further progress were made in the science of nutrition, the economic results which have been obtained in this line would be a sufficient justification for all the expenditure of money, time, and labor which has been incurred in the progress of agricultural chemistry up to the present moment. While it is doubtless true that many great discoveries are yet to be made in the domain of the science of nutrition, yet enough is now known to illustrate fully the circle of life beginning with the inorganic matters in the soil, in the air, and in the water, passing through the organism of the plant, and reaching the highest form of organized matter in the living animal. The investigations in nutrition have even gone further than this, and show how the elements of food, both for plants and animals, after having served their complete functions in one or the other of these organisms, or in both, are preserved intact, to be returned to the original condition of mineral substances in the soil, in the air, and in the water, to begin anew the circle of life. The present era, therefore, finds established as definite scientific principles the prescient predictions of the great Lavoisier concerning the methods of plant and animal nutrition.

DANGER OF EXPORTING PLANT FOOD.

The work done in the Division of Chemistry, as well as by agricultural chemists in other parts of the country, has called attention to the danger of unlimited exportation of food products containing large quantities of plant food. In fact, early in the history of the Department of Agriculture attention was called to this matter. In the Agricultural Report of the Patent Office for 1849 mention is made of the fact that prior to 1846 Ireland was an exporter of large quantities of cereals, sending abroad more of them than the whole of the United States. Much of the grain sent from Ireland was oats. The exhausting effect of cropping a field to oats is known to all practical farmers, and to this is attributed the fact of the subsequent failure of the crops in Ireland and the great suffering due to the famines caused thereby. An elaborate report on the subject of exporting plant food was presented by the present chief of the Division of Chemistry in his address before the American Association for the Advancement of Science in the Buffalo meeting of 1886. In this report the quantities of plant food removed by the crops from the fields of the United States annually were set forth. The value of plant food lost at that time by exportation of farm products was, by a careful computation, found to be over \$33,000,000 per annum. Since that time the exportation of farm products from this country has almost doubled, so that at the close of the century it is safe to say that the value of the plant food, calculated from a manurial standpoint, lost by exportation from the United States is not far from \$70,000,000 per annum.

This subject was more fully developed in an address delivered before the American Chemical Society on December 27, 1893, at the Boston meeting. While it is true, as illustrated in these addresses, that the quantities of plant food lost by exportation are less than by other causes, nevertheless the danger of exhausting the fertility of fields by the continual sale of agricultural crops is fully understood. Chemical researches in the Department of Agriculture and in other parts of the country have established this principle beyond peradventure, and have taught the farmers of the United States that one of the surest methods of retaining the fertility of their soil is to feed as much as possible of the crops produced at home. The home feeding of domesticated animals secures a large part of the value of the food in the form of manure, and this tends to diminish the rate at which otherwise the fertility of the fields would be exhausted. Chemistry has shown that there are certain products of the fields, however, which can be exported or sold with no loss in fertilizing materials. Among these may be mentioned starch, sugar, cotton, and oils and fats of every description. These bodies, contrary to the views held at the beginning of the century, are now known to have no value whatever as plant foods, and hence can be sold from the farm with impunity. It is true that no system of farming can be devised which will absolutely prevent the removal of certain quantities of plant foods in the crops; but scientific agriculture, founded upon chemical investigations, will lead farmers to that course of practical economy which will bring to a minimum the loss of fertility from this cause.

RESEARCHES ON DAIRY PRODUCTS.

The importance of the chemical composition of the dairy products was early recognized in the chemical work of the Department of Agriculture, and the Agricultural Report of the Patent Office for 1849 contains an article on the chemical properties of milk and butter. The research work of the Department on these products has been continued at intervals since that time, and important publications devoted to this subject have been issued. The Division of Chemistry, since the establishment of the Bureau of Animal Industry, has cooperated with that Bureau in the study of dairy products from a chemical and physiological point of view, and this cooperation is still continued.

IMPROVEMENT OF WORN-OUT LANDS.

Special researches have been made in the Division of Chemistry of the Department of Agriculture on the methods of improving worn-out lands. Early in the history of the Department this study was recognized as an important one, and an article is found in the Agricultural Report of the Patent Office for 1849 on the improvement of worn-out lands by the use of peas and clover. At intervals since then this subject has received the attention of chemical research, not only in the Department but in other parts of the country. A bulletin on the subject of the reclamation of worn-out lands was issued in 1894, a large part of which was contributed from the Division of Chemistry. The researches which the agricultural chemists have made, in collaboration with other scientific work of a botanical and mechanical nature, point out the way whereby lands which have been deprived of the greater part of their fertility and otherwise exhausted by culture may be restored to a high degree of fertility. In many parts of the United States are found abandoned fields and even farms, since it has been found more profitable to search for new and fertile soils than to develop and restore old and worn-out fields. At the present time, however, the area of virgin fertile soils is practically exhausted, and the attention of scientific agriculture is now directed with more energy than ever to the restoration of the fertility of soils long since abandoned. It is certain that in the near future the practical farmer, with the aid of chemical research, will effect the restoration of the greater part of the agricultural lands of the United States, which have heretofore been abandoned to briars and brush, to their natural position as fertile and profitable fields.

CHEMISTRY IN THE DEPARTMENT OF AGRICULTURE.

Perhaps there is no other method in which the researches of chemistry have been made practical for agricultural purposes in a more general way to the agriculture of the United States than through the work of the Department of Agriculture. So long as the work of the Department was conducted in the Patent Office, chemical investigations of agricultural subjects continued to be the chief scientific inquiry.

ANALYSIS OF GRAINS AND OF FLOUR AND MEAL MANUFACTURED FROM THEM FOR EXPORTATION.

The first appropriation in this country for purely scientific services in agriculture was made at the first session of the Thirtieth Congress, when $1,000 was given "for the institution of a system of analyses of different grains produced in this country and of flour manufactured here and exported abroad."

The important problems which it was sought to solve in these investigations were the effect of soil and climate upon the different varieties of grains and the effect of a sea voyage and storage upon the flour and meal manufactured from grains produced here and sent abroad.

Prof. Lewis C. Beck, of Rutgers College, New Brunswick, N. J., an experienced analytical chemist, was employed to conduct the chemical work. The Commissioner of Patents made efforts to receive samples of wheat, indian corn, and flour from the ports of the most distant countries to which they had been exported. Professor Beck's report is made an appendix to the Agricultural Report of the Patent Office for the year 1848. Professor Beck, in introducing his report, enters into an elaborate discussion of the economic relations of chemical studies to agriculture. He states that in 1847 breadstuffs worth $43,000,000 were exported from this country to Great Britain and Ireland alone. He is of the opinion that the best method of determining the real value of wheat and other flours is to examine the bread made from them, and calls attention to the fact that chemicals are used in some countries in the manufacture of bread in order to conceal the defects of the flour from which it is made.

In Belgium and the north of France it is stated that sulphate of copper has been introduced into the manufacture of bread, and that the use of alum has been practiced from a remote period. In addition to these, the alkaline carbonates, the carbonate of magnesia, chalk, pipeclay, and plaster of Paris have all been employed in the manufacture of bread from inferior or damaged flour in order to preserve its moisture or to increase its weight and whiteness. Further adulterations of bread are stated to be with potato starch and flour of leguminous plants, buckwheat, and rice, and citations are made to the literature where the methods of discovering these adulterations can be found. Professor Beck quotes largely from Boussingault's "Rural Economy," Dumas's "Traité de Chimie Appliquée aux Arts," and from Davy's "Agricultural Chemistry." The method of analysis employed by him is fully set forth, and the data obtained from the numerous analyses are given, showing the amount of water, gluten, starch, and sugars contained in the various samples. In all, thirty-three samples of flour were analyzed, collected from different parts of the country, and from distant ports to which flour from this country had been shipped.

It is thus seen that several of the most important lines of investigation which have subsequently been followed in the chemical work of the Department were marked out at this early period by Professor Beck. He introduced the first systematic work in determining the character of the cereals of the country, published methods of analysis for the guidance of other chemists engaged in similar work, and began the investigation of the great subject of food adulteration.

A similar work on indian corn was conducted by Dr. J. H. Salisbury, of Albany, N. Y., and the results of his analyses were published in the report for 1849.

ESTABLISHMENT OF DIVISION OF CHEMISTRY.

In 1862 the Department of Agriculture was organized on an independent basis. In the organic act establishing the Department it is stated that the Commissioner of Agriculture shall "employ other persons for such time as their services may be needed, including chemists, botanists, entomologists, and other persons skilled in the natural sciences pertaining to agriculture."

It is thus seen that chemistry was recognized, by its assignment in the order of mention, as of the first importance in the scientific work of promoting agriculture throughout the country. In accordance with the authority vested in him by the organic act, Isaac Newton, who was the first Commissioner of Agriculture, established the Division of Chemistry by the appointment of Dr. C. M. Wetherill, a distinguished chemist, as the first chief of Division. Dr. Wetherill was appointed Chemist on August 21, 1862, and served until some time in 1863.

Commissioner Newton, confirming the statement made by Judge Buell more than twenty years before, gave as the first of the scientific objects of the Department "analysis, by means of a chemical laboratory, of various soils, grains, fruits, plants, vegetables, and manures, and publishing the results for the guidance and benefit of agriculturists."[1] Of the work of the Chemist for the first year, the Commissioner said:

> Fortunately the Chemist to the Department was in possession of an extensive scientific library and apparatus, which he kindly placed at my disposal at the commencement of my duties as Commissioner. The season had so far advanced, however, that but few tests could be made. The Chemist has, nevertheless, analyzed some twenty-two varieties of grapes, and is at present engaged in the examination of ten or twelve varieties of wines, also sorghum from eight or ten different localities, in order to determine the relative value of sirup and its capabilities for producing sugar and molasses, as compared with sugar cane. As soon as arrangements now being made in the laboratory are completed, the Chemist will enter into the analysis of the various grasses and grains of the United States, in order to learn which will produce the greatest amount of fat, flesh, muscle, and bone; also of soils, manures, and the constituents of plants, with especial reference to restoring fertility to exhausted farms.

REPORTS OF THE CHEMISTS.

On January 1, 1863, the first report of the Chemist of the Department of Agriculture was submitted for publication. This report is interesting as the first one on a scientific subject ever made to the Department by a person employed exclusively for the conduct of scientific work. The Chemist's report covers the analysis of grape juices, of sorghum and imphee, the examination of various sugars and sirups, the analysis of beets, and an article on the chemistry of sugar manufacture in general. Thus, at the very outset of the special relations of chemical science to the Department of Agriculture, some of the most important lines of investigation which have since been followed were established. Chief among these may be mentioned the study of the wine-making industry, both from the fermentative and chemical points of view, and the beginning of that study in the chemistry and technics of sugar manufacture, which has since done so much to establish an indigenous sugar industry in the United States.

The Annual Report of the Commissioner for 1863 contains no report from the Chemist of the Department.

The report of the Chemist for 1864 (Mr. Henry Erni[2]) relates to organic or vinous fermentation, acetic fermentation, butyric-acid fermentation, theories of the origin of mold, or fungi, methods of detecting the artificial coloring matters in wines, the analysis of wines, and the analysis of soils and guanos.

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[1] Report of the Commissioner of Agriculture, 1862, p. 20, object 5.

[2] Appointed probably July 1, 1864.

The report for 1865 was devoted to the analysis of soils, sugar beets, sorghum and imphee, wines, and miscellaneous work of various descriptions.

In 1866 Dr. Thomas Antisell[1] was appointed Chemist of the Department. His first report was devoted to the analysis of soils and manures, agricultural products, and mineral and metallurgical analyses. During this year also the cooperative work between the Division of Chemistry and other Departments was begun. Dr. Antisell says, on page 45 of the Annual Report: "Besides the foregoing, the laboratory has been engaged with analyses for other Departments of the public service."

Dr. Antisell, in his report for 1867, enters into an elaborate discussion of the analysis of sugar beets and of the sugar-beet industry, thus having laid the foundation for the extensive developments in the investigations along this line, which have been carried on by the Division of Chemistry for the past thirty years. In order to increase the efficiency of the work of the Division, Dr. Antisell suggested that the scope of its work should be enlarged so as to embrace the relations of geology to agriculture and to include the study of metallurgy. He suggested that geology had intimate relations to agriculture, and advised the establishment of a geological and mineralogical laboratory and museum to illustrate the economical relations of geology to the agriculture of the United States. He says: "Whatever relations of soils to their parent rocks exist would thus be brought out in a prominent and systematic manner." It will be observed from this reference that the first official recommendation for the establishment of a geological survey emanated from the Division of Chemistry of the Department of Agriculture, as well as the suggestion of the study of meteorology and other matters connected directly with agricultural crops.

In 1868 the chemical laboratory was removed from the Patent Office to the building of the Department of Agriculture, which had just been completed. The report of the Chemist for that year contains a reference to the newly discovered phosphatic deposits of South Carolina, with remarks upon their value for agricultural purposes.

The report for 1869 contains an interesting article on the analysis of soils. The Chemist also urges the establishment of an experimental garden, where the problems involved in chemical research could be studied actually in the field. This recommendation was a reiteration of one previously made by him in the same direction. The importance of practical experimental stations in connection with chemical research is thus early in the history of the work of the Division properly recognized.

The report of the Chemist for 1870 contains an interesting article on the alkaline soils of the West, giving a complete study of their

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[1] Appointed probably July, 1866.

physical and chemical properties, especially an account of the determination of the soluble matter in the surface. The first work which had been undertaken on the composition of meat extracts is also discussed in the report, as well as the foods used by the Indians.

The work for 1871 is described by the Commissioner in his report for that year as being memorable on account of the beginning of two extensive investigations. One of these was the analysis of several hundred specimens of cereals carefully selected from the entire production of the country. The other was the examination of the leaf, stem, and fruit of the grapevine during every week of its growth. The Commissioner says: "By this work it is expected that new analogies in animal and vegetable physiology will be established and information gained which bears directly upon the diseases of the vine."

From the earliest establishment of chemical researches in the Department, a large part of the time of the Chemist and his assistants had been taken up with analyses not at all relating to agriculture. Chief among these were the assay of gold and silver ores and the study of samples for commercial purposes for private individuals and corporations. This perversion of the proper functions of the Division of Chemistry had been so pronounced as to warrant the Commissioner to say in the report for 1871: "To enable the Chemist to devote himself to those important subjects in agricultural science which await and demand chemical research, I am strongly of the opinion that the public privilege should be restricted to the employment of the laboratory for such purposes only as relate to agriculture."

In July, 1871, Dr. Antisell resigned the position of Chemist, and on January 11, 1872, Dr. R. T. Brown was appointed to the position. The report of the Chemist for that year emphasized the importance of sodium nitrate as a manure, and the value of the deposits in Peru, Chile, and Bolivia for agricultural purposes is mentioned. Attention is called to the fact that the soils of the blue-grass region of Kentucky renew their stock of phosphatic materials by the decomposition of the limestone rocks, and this observation has in later years been confirmed by the researches of the agricultural experiment station of Kentucky, which show that these soils are never deficient in phosphates, but only in potash and nitrogen. The importance of bone and natural phosphates for fertilizing purposes is more fully brought out in this report than in any previous contribution from the Department, and large numbers of analyses of commercial fertilizers are given.

In 1872 the report was devoted largely to the analysis of commercial fertilizers and sugar beets. An important contribution is also found in this report on the utilization of the wastes of cities and towns for agricultural purposes, a subject which has since received very careful investigation in the Division of Chemistry.

In 1873 Dr. Brown resigned and was succeeded by Dr. William McMurtrie, who held the position until January 2, 1878.

In the first report of Dr. McMurtrie attention is again called to the fact that the Department has been very much troubled with applications for analyses of minerals, ores, commercial products, etc., which have little or no bearing upon agriculture or agricultural chemistry. The work during the first year of Dr. McMurtrie's incumbency was largely devoted to the analysis of wines, fertilizers, and soils. An interesting résumé of the knowledge at that time relating to humus is given, with references to the work of Grandeau on that subject. Another interesting article in this report is a contribution on the approximate composition of cereals, indian corn being the one selected for study. The first investigation relating to tanning materials was also reported at this time.

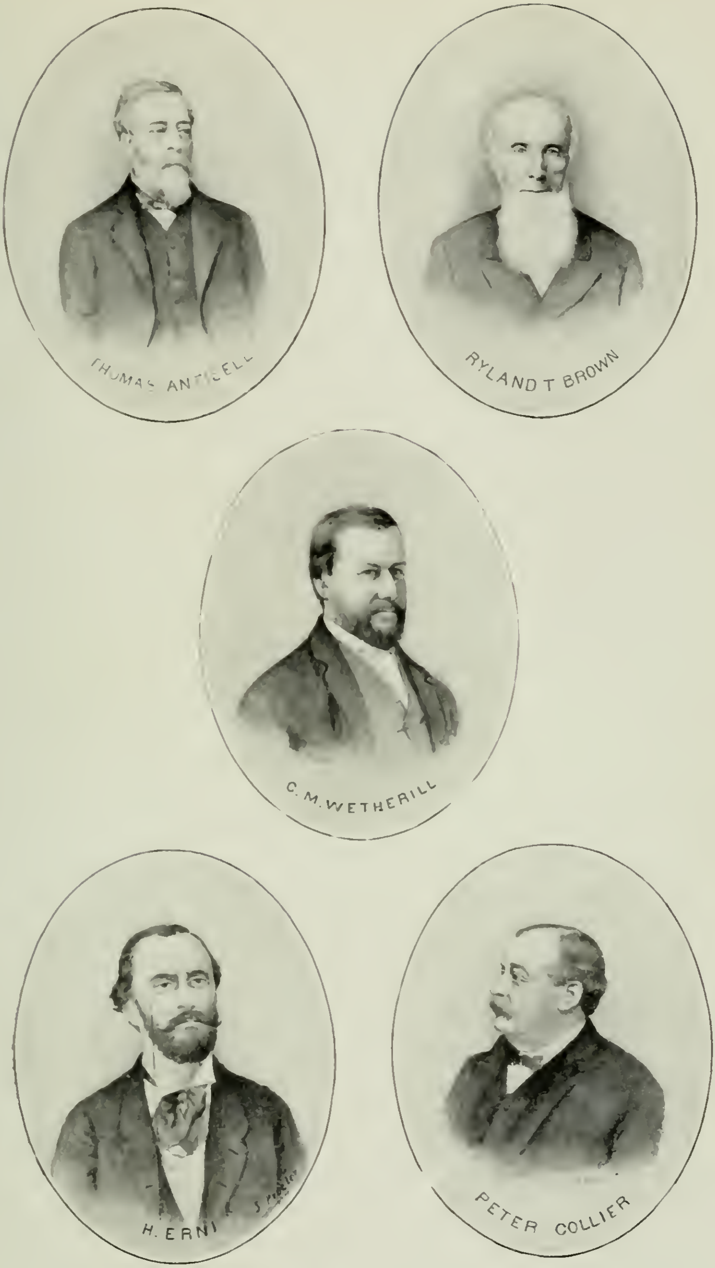
The Chemist's report for 1874 includes a report of an investigation of the fodder plants of the South and a study of insecticides, especially Paris green, in regard to their use in agriculture. Reference is also made to the work of Dr. Goessmann, of the Massachusetts Agricultural College, on the culture of the sugar beet. This was the beginning of Dr. McMurtrie's investigations of the sugar-beet industry, which he afterwards carried forward with such success and advantage to American agriculture.

In the work of 1875 the first studies were commenced in chemical processes affecting agriculture by the actual growth of plants. A series of valuable experiments was conducted in the application of insecticides to growing plants. The effects of these insecticides were carefully noted and photographs representing the plants treated were secured and published. Similar experiments were made to show the effects of illuminating gas upon vegetation. This was the beginning of the realization of the recommendations made by Dr. Antisell for the practical investigation of agricultural chemical problems upon the plant itself.

The report for 1876 refers to the part taken by the Division in the Centennial Exposition which was held during that year at Philadelphia.

The work for 1877 is summarized in the report of the Chemist under nine different heads, namely: (1) Analysis of lime marls; (2) examination of soils; (3) analysis of bat guano; (4) analysis of sugar from Early Amber sorghum cane; (5) estimation of the amount of sugar in various beets sent to the Department; (6) the examination and report of an experiment in beet culture made on Batsto farm, Atlantic County, N. J.; (7) experiments to determine the presence or absence of the so-called peptone-forming ferment in the roots of plants; (8) investigation of American sumac; (9) investigation of the physical and chemical causes tending to the production of mildew and rot. The latter investigation is interesting from the fact that it indicates that the first beginnings of studies of this kind were established in the Division of Chemistry.

At the beginning of 1878 Dr. McMurtrie resigned to accept the



DECEASED CHIEFS OF THE DIVISION OF CHEMISTRY.

position of representative of the Department at the international exposition to be held at Paris during the year, and January 22, 1878, Dr. Peter Collier was appointed Chemist in his stead.

The first report of Dr. Collier covers the beginning of the work conducted by him on the production of sugar from indian-corn stalks and from sorghum. While, however, during this first year only 8 samples of these sugar-producing plants were examined, 57 sugar beets were analyzed. A joint report of the Botanist and Chemist on grasses and forage plants, issued January, 1884, is interesting as showing, in an ideal way, the methods in which the different scientific Divisions of the Department may collaborate in advancing the interests of agriculture. Dr. Collier held the office of Chemist until April 9, 1883. During this time a large part of the activity of the Division of Chemistry was devoted to the study of sorghum as a sugar-producing plant, and the most extensive series of analyses ever instituted up to that time for agricultural purposes was conducted under his direction.

The reports prepared by Dr. Collier on this matter and appearing in the several annual reports deal with every phase of the subject, chemical, agricultural, and technical. The high price of sugar at this time excited the interest of investors in the subject of the practical manufacture of sugar from sorghum, and a large amount of capital was placed in this business. Unfortunately for the sorghum industry, the rapid development of the beet-sugar industry in Europe brought into competition with sorghum a sugar-producing plant which, under the impetus of careful chemical study and technology, rapidly produced a surplus of sugar in the markets of the world, causing an unprecedented fall in price. The difficulties attending the manufacture of sugar from sorghum, due to the chemical composition of the plant, were not solved with sufficient rapidity to enable sorghum to remain as a competitor for supplying the sugar markets of the world. As a result of this combination of economic, chemical, and technical causes, the production of sugar from sorghum never became profitable. While, as stated, the study of the sugar problem was the main work of the Division of Chemistry during the incumbency of Dr. Collier, other matters, relating to agricultural industries were not neglected. The study of soils and fertilizers was continued without intermission, and the foundation was laid for the systematic study of cereals, which afterwards became so important a part of the work of the Division.

The portraits of the deceased chiefs of the Division of Chemistry are given in Pl. V.

LINES OF WORK IN THE DIVISION OF CHEMISTRY SINCE 1883.

Since April, 1883, the work of the Division of Chemistry in its relation to the progress of agriculture has been directed chiefly along the following lines:

Study of sorghum.

The study of sorghum as a sugar-producing crop was continued with the special object of overcoming, if possible, the difficulties which had stood in the way of a successful industry. At first the work was more of a chemical and technical nature, looking to the establishment of methods to secure more economical working and larger yields. To this end, the diffusion process of extracting the sugar from the canes, which had been so successfully used with beets in Europe, was applied to sorghum with such modifications as the different nature of the material required. An increase in the amount of sugar extracted from the canes was easily obtained, but the greatest difficulty in the way of successful sugar making still remained, namely, the chemical composition of the extracted juices. It was found that the juices extracted from sorghum canes contain large quantities of starch, gummy matters, and uncrystallizable sugars. These existed in such large proportions as to render the separation of the sucrose in large quantities practically impossible. Various chemical methods of removing these impurities were devised and applied. Among them, the two which promised most success were the process of saturation with lime, or carbonatation, as practiced with beet juices, and the removal of the starchy and gummy matters by precipitation with alcohol. The former method, after a thorough trial, was abandoned as impracticable. The latter method resulted in a complete success, yielding with canes of average composition 200 pounds of sugar per ton. The fiscal regulations covering the production and use of alcohol in this country, however, were of such a nature as to render the use of this reagent impracticable from an economical point of view without some change in the excise laws of the country.

Meanwhile other investigations were carried on with great success; among them the process of developing a variety or varieties of sorghum in which the objectionable qualities would be reduced to a minimum and the percentage of sugar raised to a maximum. This desirable end was accomplished by a series of culture experiments in cooperation with Mr. A. A. Denton extending over eight years, in which, by a process of selection, both from the point of chemical composition and from physical qualities, several varieties of sorghum were developed, which were far superior to any which had before been known. It was established by the researches of the Division that fields of sorghum could be grown having an average sugar content of 14 per cent and with a much higher purity than characterized the parent canes from which the varieties were derived.

In spite of all the progress made, however, it was found that the increasing competition of sugar derived from the sugar beet had decreased the price of sugar in the world's markets, until it would not be profitable to manufacture sugar from sorghum, even under the more favorable circumstances which obtained. But the final results of these investigations were not without their practical value, as the utility of sorghum as a source of table sirups and as a cattle food was fully developed and established. It was also shown that in the semiarid regions of the country, where the practice of irrigation was not possible, there is no crop which is so certain to bring a remunerative yield as sorghum when cultivated in the proper manner.

The final result of the work conducted by the Division over a period of more than twenty years on sorghum as a field crop has established its status as one of the most remunerative plants when cultivated in certain areas of the country. In fact there is scarcely any part of the United States where sorghum is not cultivated, and even in Minnesota the finest table sirups which are found upon the market in that region are made from one of the early varieties of sorghum cane which grows to maturity in the short summer seasons of that State.

Study of cereals.

Another line of investigation which has been carried on extensively during the past seventeen years has been a study of the composition of the cereals of the United States. This work, it is true, as has been stated, is only a continuation of the very first scientific work authorized by the Government when the Department was still a section of the Patent Office. The opportunities, however, for the use of more accurate means of analysis and to secure samples grown under different conditions, from more widely separated areas, have made the continuation of this study one of the most profitable for the advancement of agriculture. The bulletins which have been issued on this subject embody the results of many thousands of analyses, and show with greater fullness and accuracy than any other publications which have been issued the variation of cereal products under different conditions of soil and climate. The successful work of improving a plant by selection and taking advantage of natural variations, as illustrated in the case of sorghum, has now been applied to the study of cereals. The causes which produce variations are under investigation, and also the methods for improving the composition of cereals with reference to certain of their more valuable constituent parts. For instance, the percentage of gluten in wheat is of the utmost importance to the bread maker, since it is this body which gives to wheat flour the physical characteristics that render it more valuable than that from other cereals for bread-making purposes. Under the varying conditions of soil and climate in this country it is found that the content of gluten in wheat changes. The utmost practical advantage, therefore, will come to the wheat grower from a practical study of this cause and suggestions of the best methods of preserving or increasing the content of gluten in wheat.

The broad principle has been established that, other things being equal, wheats from a high northern latitude contain more gluten than those grown farther south and the wheats that are sown in the spring a larger quantity of gluten than those which are planted in the autumn. It is believed, however, that a careful chemical study of this subject in connection with the proper study of meteorological conditions will enable wheat growers to largely increase the content of gluten in the autumn-grown and southern wheats.

Study of food adulteration.

The practice of adulterating human foods, which has been so largely prevalent in all parts of the world, has proved of incalculable injury to honest agriculture. The value of scientific farming in its ultimate measure is determined by the benefit which accrues therefrom. If the returns from scientific farming prove to be less than those from unscientific methods, the latter will certainly prevail. The markets for farm products must therefore be preserved with as much care as the fertility of the fields. The sole object of food adulteration is to enable the unscrupulous manufacturer or dealer to sell an inferior article at the price of a superior. Food adulteration, therefore, which totally changes the aspect of the food of an inferior kind so that it does not at all resemble the superior kind would defeat its own purpose. Every pound of adulterated food which is sold upon the market at the price of the genuine article or at a price approximating thereto is a positive injury to agriculture, since it excludes from the market an equal quantity of farm products of a genuine character. Thus, the practice of food adulteration directly diminishes the profits of the honest farmer and dealer.

Much of the activity of the Division of Chemistry during the past seventeen years has been directed to a study of the methods and character of food adulteration with a view to devising proper legal restrictions for its prevention. To this end a large part of the scientific corps of the Division has been assigned to a systematic study of the adulteration of foods, and the results of these studies have been published in numerous bulletins relating to that subject. The object of these studies is to finally cover the whole range of food production, and this has already been largely accomplished.

As an illustration of the way in which adulterated foods may injure the farmer's profession may be cited the sale of oleomargarine for butter and glucose for honey. The food value of oleomargarine and of glucose is not denied. They are, however, very much cheaper products than butter and honey. These adulterated foods, unfortunately, are often not offered for sale under their own names, except by legal compulsion, but are placed upon the market under the names of the genuine articles which they are manufactured to imitate. Buyers, therefore, pay, as a rule, prices which would be asked for the pure articles. The market for the pure articles is diminished just to the extent to which these other substances are sold, and in this way positive injury to great agricultural interests is done. The chemists of many of the agricultural experiment stations throughout the country have collaborated with the Division of Chemistry in these studies, so that the whole subject of food adulteration is pretty thoroughly understood and its extent acknowledged. Many of the legislatures of the States have already enacted restrictive measures regulating the sale of adulterated foods, and bills have been before the Congress of the United States having the same object in view. The work in which the Division of Chemistry was a pioneer has commended itself to the people at large, and through the press and before farmers' institutes full descriptions of the methods and character of adulteration have been disseminated among the people. Public opinion has been so aroused on this subject as to demand of the National Legislature the enactment of laws regulating commerce in adulterated foods in the Territories of the United States and between the several States thereof. The work of the Division has therefore already secured great benefits to agriculture in the way of preserving an honest market for the products of the farm, and made it possible for these benefits to be greatly increased by favorable national legislation on the subject.

Comparative studies of soils.

For the past seventeen years the Division of Chemistry has continued its researches in the study of the soils of the United States. Before the organization of the Association of Official Agricultural Chemists, and for the benefit of agricultural chemists throughout the country, a bulletin was prepared giving the results of soil studies and a summary of the best methods known at the time for conducting them. In order to study comparatively typical soils special authorization was obtained from Congress for the establishment of a vegetation house in which soils from different parts of the country and even from foreign countries could be studied under similar conditions in respect of their powers of producing organic matter and in their relations to nitrifying organisms. In no other way can the relations of different soils from the point of view of their chemical and physical composition in producing crops be so definitely determined. A knowledge of the soil is the fundamental structure on which agricultural chemistry is built. While in all parts of the world numerous experiments have been carried on to determine the relative value of fertilizing principles on plant growth, it is believed that the comparative determination of native soil fertility under standard meteorological conditions has first been studied in this Division. The great problem of human nutrition is to find its only solution in the maintenance or increase of soil fertility, and hence every study of this kind which tends to give additional knowledge regarding the cause of fertility and the means whereby it can be maintained, is of the highest economic importance. The complete triumph of agricultural chemistry will be realized when with increased crops shall be found increased soil fertility.

The system of agriculture which has so largely prevailed in this country of exhausting the fertility of one field and then moving the farm to another has come to an end. Scientific agriculture now retraces its steps and restores the fertility of the abandoned fields while it prevents the exhaustion of those which are still productive. Agricultural chemistry in its fullest development will only ask of nature to furnish meteorological conditions and a place on which to plant the crops. Even these will be modified and changed to suit the demands of the agriculture of the future, for it is certain that by the proper manipulation of the soil and the addition of proper chemical fertilizers the capacity for retaining moisture for use in seasons of drought or for disposition of excessive moisture in seasons of rains will be greatly increased. With a wise disposition of the water at his command, the scientific farmer of the future will cultivate millions of acres which are now regarded as hopelessly arid, and recover from the excess of water other large areas now abandoned to swamps and marshes. In these scientific studies of soil composition and soil possibilities with relation to the composition of plants and to increased fertility will be found in the future, as has been the case in the past, some of the most notable triumphs of agricultural chemistry.

In connection with these soil studies, there has also been made a systematic study of the nitrifying organisms through whose agency organic and atmospheric nitrogen become available for plant food. A practically new system of soil analysis has been inaugurated by which it is possible to determine both the number and activity of the nitrifying organisms contained in a sample of soil. These researches are of the greatest practical benefit in agriculture, since they show how the number and activity of nitrifying organisms can be increased, and thus the availability of the nitrogenous food of plants be enhanced. An outline of the relations of these studies to practical agriculture has been prepared for this paper by the first assistant of the Division of Chemistry, Mr. E. E. Ewell.

RELATION OF MICROORGANISMS TO NITROGEN NUTRITION OF CULTIVATED PLANTS.

EARLY STUDIES OF MICROORGANISMS AND NITROGENOUS PLANT FOOD.

The development of the prevailing opinions relative to the rôle of the microorganisms in the preparation of the nitrogenous food of our cultivated plants is a long story. Indeed, its beginning may be traced back to the closing years of the eighteenth century (1770 to 1800), during which period the labors of Black, Scheele, Priestley, Lavoisier, Cavendish, Watt, Ingenhousz, Senebier, and Woodhouse established the chemical nature of the constituent gases of the atmosphere—nitrogen, oxygen, carbon dioxid, and water vapor—and began the study of the relation of these substances to vegetable growth. Early in the present century De Saussure materially advanced the knowledge of the processes by which the carbon dioxid and the water of the atmosphere and of the soil are converted into vegetable tissue, and expressed the opinion that the nitrogen therein contained was obtained from the compounds of that element found in the soil and in the air; but the relation of atmospheric nitrogen to vegetation remained obscure until within two decades of the century's close.

Boussingault devoted a considerable part of twenty years (1837–1858) to the study of this question. His experiments seemed to show conclusively that plants are unable to use the free, uncombined nitrogen of the air for the construction of the nitrogenous bodies which form parts of their tissues, and that their nitrogenous food is exclusively drawn from nitrogen compounds contained in the soil.

The experiments of Ville (1849–1854) led to precisely the opposite conclusion. In 1854, appreciating the importance of the subject, the Academy of Sciences of France appointed a commission, consisting of Dumas, Regnault, Payen, Decaisne, Peligot, and Chevreul, to observe and report upon a repetition of these experiments to be conducted by Ville, with the assistance of Cloez, in the Muséum d'Histoire Naturelle. In 1855 Chevreul reported on behalf of the commission "that the experiment made at the Muséum d'Histoire Naturelle by M. Ville is consistent with the conclusions which he has drawn from his previous labors."

Messrs. Lawes and Gilbert, at their now famous experimental farm at Rothamsted, England, have devoted much time to this question since 1857. Their earlier experiments (1857–1860) were negative for both leguminous and nonleguminous plants, thus contradicting the results of Ville and confirming those of Boussingault.

Two of Boussingault's experiments, made 1858–59, seemed to indicate that free nitrogen had been brought into combination either by some lupine plants or by the rich garden soil in which they were growing. He did not accept these results as evidence of the assimilation of nitrogen by plants, however, as is indicated by the following from his letter to Gilbert, dated May 19, 1876:

> As for the absorption of the gaseous nitrogen of the air by arable soil, I know of not one single irreproachable observation that establishes it. Not only does the soil not absorb gaseous nitrogen, but it emits it, as you and Mr. Lawes have observed, as Reiset has found in the case of manure, and as Schloesing and I have noted in our researches on nitrification. If there is a perfectly demonstrated fact in physiology, it is that of the nonassimilation of free nitrogen by vegetation, and I may add by the lower plants, such as the mycoderms and fungi.

Many other investigators devoted much time to this question between the years 1850 and 1886: Cloez and Gratiolet, 1850–1855; Méne, 1851; Petzholdt, 1852–53; Wolff, 1853–1886; Hasting, 1855; de Luca, 1856; Dehérain, 1875–1885; Berthelot, 1876–1886; Atwater, 1883–84; Dietzel, 1884; Joulie, 1885; Frank, 1886.

This long series of experiments, covering more than half a century of time, were contradictory, one of another, erroneous in conception in some cases, and erroneous in manipulation in others, while the conclusions drawn from them were correspondingly inaccurate and incomplete. The most fruitful source of wrong conclusions was, however, to be found in the fact that in the zeal of many of the workers to deprive their experimental soils of compounds of nitrogen they so treated them as to destroy what we now know to be the potent factor in the assimilation of free nitrogen by plants—the microorganisms which form the nodules upon the roots of leguminous plants and thereby enable the plants of that order to indirectly draw upon the atmospheric store of uncombined nitrogen. Attention had frequently been drawn to these peculiar nodular structures on the roots of clover, lupines, beans, etc., notably, by Lachmann in 1858, by Berkeley in 1863, and by Rautenberg and Kuehn in 1864. Indeed, it was suggested by some of these writers that possibly the nodules were connected in some way with the taking in of nitrogen by the plants. It came to be a well-established fact that there was a something that distinguished the manner of the nitrogen nutrition of leguminous plants from that of other plants. They were found to contain more nitrogen than it seemed possible for them to obtain from the combined nitrogen of the soil and the atmosphere in which they grew.

WORK OF BACTERIA IN THE SOIL IN SUPPLYING NITROGENOUS FOOD FOR LEGUMINOUS PLANTS.

At the Berlin meeting of the agricultural section of the Naturforscher-Versammlung, September, 1886, the late Professor Hellriegel read a paper disclosing results which have revolutionized our ideas relative to the nitrogen nutrition of plants, and which show the mistakes and the blindly groping nature of the experiments enumerated above. This paper throws a flood of light upon the path to be followed by practical agriculturists in the future. In short, Professor Hellriegel proved by evidence which has been accepted by the entire scientific world that the root nodules of leguminous plants are caused and inhabited by a species of bacteria; that these bacteria, by their symbiosis, enable the plants to indirectly feed upon the practically unlimited and costless store of free nitrogen, which forms eight-tenths of the earth's atmosphere. True, clover and other leguminous plants had previously been valued as soil renovators, but we are now able to use them with an understanding and a confidence hitherto impossible; with the hope that by their use as green manure, as food for farm animals, and as a source of merchantable produce, we may maintain the fertility of our fields, in so far as the element nitrogen is concerned, without the costly use of artificial nitrogenous manure, the nitrogen compounds of which will thereby be preserved for other industrial needs.

There is still some investigation needed to determine the most certain and economical methods of insuring an abundant supply of the nodule bacteria in soils on which leguminous crops are to be grown. Nobbe and Hiltner have secured patents for the manufacture and the use of pure cultures of several varieties of nodule organisms. These cultures are prepared on a commercial scale in Germany and placed on the market under the name of "Nitragin, a germ fertilizer for leguminous crops." The value of these preparations has been investigated by the experiment stations of Europe and of this country, but the results thus far obtained are conflicting.

WORK OF BACTERIA IN SUPPLYING NITROGENOUS FOOD FOR PLANTS IN GENERAL.

We have to this point only mentioned the microorganisms that participate in one method of nutrition of the leguminous plants. We have yet to consider those microorganisms which are active in the preparation of the nitrogen compounds on which plants in general feed, including leguminous plants growing without the assistance of the nodule bacteria. It now appears well established that combined nitrogen, chiefly in the form of nitrates, is practically the sole nitrogenous food of agricultural plants in general.

It is to be noted, however, that a method for enabling nonnitrogenous plants to draw their supply of nitrogen from the atmosphere has been brought to the attention of agricultural scientists during the last decade. The cultures of the organism for which this property is claimed are manufactured in Germany and sold under the name of "Alinit." The experiments which have hitherto been made with "Alinit" as an agent for soil inoculation have not confirmed the claims of Caron, the German agriculturist, who discovered the *Bacillus ellenbachensis* α, the organism contained in "Alinit," and the interesting properties with which he credits it. There is, however, some experimental evidence, obtained in the laboratory, which is more favorable to it.

Since we must furnish our agricultural plants in general with an abundant supply of nitrogenous plant food, chiefly in the form of nitrates, there is no more important question in agricultural science than that of the manner in which this is to be done with certainty and with the greatest economy. Although the judicious introduction of leguminous plants into our systems of crop rotation and stock feeding may make the farmer independent of the dealer in commercial nitrogenous manures, it is still necessary to study with earnestness the methods by which the supply of crude nitrogenous compounds contained in barnyard manures and in crop residues are to be transformed into nitrates speedily and with the least possible loss.

It has long been a common experience that straw, manures, etc., when incorporated with arable soil, are found to have disappeared after some weeks or months, and that crops planted on the soil so treated grow more luxuriantly than upon adjoining unmanured land. The agencies by which organic matter is thus destroyed and changed into plant food were not at all understood at the beginning of the present century. Some of the most important facts remained unknown until the eighth decade, and even now there are many points requiring further elucidation.

The first six decades of the century were spent in experiments and disputations which served to determine the relations of microorganisms to the phenomena of fermentation and putrefaction, and to settle in the negative the much controverted question in regard to the spontaneous generation of those organisms. In this connection, we must recall the names of several persons prominent in the controversy, or in the events which led up to it: The Hollander Antoon van Leuwenhoek, "the father of micrography," who lived from 1632 to 1723, was the first to observe minute organisms in fermenting and putrescent liquids by means of the microscope; Needham, 1754, and Spallanzani, about 1760–1770, who were champions pro and con, respectively, of the theory of spontaneous generation; Schultze, 1836, who first asserted that the phenomena of putrefaction and fermentation are induced by the microorganisms ever present in the air and not by spontaneously created organisms; Schwann, 1839, founder of the science of antiseptics, who was another opponent of the theory of spontaneous generation; Liebig, who asserted in 1839 and for many years after that fermentation and putrefaction are not biological phenomena; Schröder and Dusch, 1853, who were inventors of the use of cotton wool for freeing a stream of air from microorganisms; Pasteur, who, beginning the study of the question in response to a prize offered in 1860 by the Paris Academy of Science, demonstrated that any substance whatever may be freed from the germs of putrefaction by a suitably prolonged heating at a sufficiently high temperature, and that the substances so sterilized will maintain that condition indefinitely if the access of organisms from the air is prevented.

This forms the starting point from which has been developed, by a host of workers, our knowledge of the organisms of putrefaction and decay, the changes which they work in the media in which they grow, and the conditions which favor or hinder their growth. It was early discovered that a great number of species of organisms is engaged in the destruction of organic matter in soils and other substances, and that the final products of the process are carbon dioxid, water, and ammonia, with some free nitrogen, and hydrogen in some cases.

It was a well-known fact, however, that ammonia does not accumulate in arable soils in any such quantities as do nitrates, especially under conditions highly favorable for the phenomenon of nitrification, as in the artificial and natural nitrate beds, which were under observation in various parts of the world.

The next point of contention was very naturally the nature of the process by which the nitrogen of ammonia is converted into the form of nitrates under natural conditions. Although Müller, in 1873, and Pasteur, as early as 1862, had suggested the possibility of its being a biological phenomenon or species of fermentation, the change was generally regarded as a purely chemical one, probably wrought by the highly condensed oxygen supposed to exist in the interstices of the soil and of other porous substances. This doctrine was overthrown by the experiments of Schloesing and Müntz (1876), which showed that nitrification is interrupted by the action of antiseptics (chloroform), and that the process can be started again by inoculating the medium with a small amount of fresh soil. These experiments were soon repeated and extended by the discoverers and by Warington, Soyka, and others. An additional proof of the fermentative nature of the process of nitrification was found in the fact that it was stopped by heat when applied in the manner in which it is usually employed for sterilization. During the next thirteen years (1878–1890) many workers took up the study of the nitrifying organisms, and much valuable knowledge relative to their properties was obtained, but the numerous attempts to satisfactorily isolate them and study them apart from the host of other soil organisms were fruitless. Again, an unknown factor rendered futile the efforts of some of our best experimenters, as had been the case in the investigation of the question of the fixation of free nitrogen by agricultural plants, mentioned above. The valuable method of gelatin-plate cultivation invented by Koch for the isolation of bacteria, was found to be inapplicable. Indeed, numerous failures led Frank, as late as 1887, to assert that there could be no organism of nitrification, since no organism separated from the soil was found to possess that property, in spite of the fact that numbers of experimenters had transferred the nitrifying agent from culture to culture, in liquid media, by the usual method of inoculation. It gradually became apparent that the organic matter habitually used in the media employed in plate cultivations was unfavorable to the growth of the nitrifying organisms. Indeed, by repeatedly reducing the proportion of organic matter used in the preparation of liquid media, in which nitrification proceeded satisfactorily, a medium was finally tried which contained no added carbon other than that of the alkaline or earthy carbonates which had been found necessary to neutralize the acid formed by the process, and of which an excess had been found to be detrimental. In this medium the process proceeded with the vigor normal for the liquid media hitherto found most favorable.

Here then was the key to the situation. The organisms of nitrification do not thrive in the presence of an excess of organic matter. In 1890 a new investigator entered the field, a young Russian named Winogradsky. His first triumph was in a satisfactory isolation of the nitric organisms by means of culture plates composed of gelatinized silica, impregnated with nutritive salts and carbonates, but made without any added organic matter whatever. His work upon the subject was temporarily interrupted, but it is now in progress with one or more collaborators.

In addition to the above, there must be mentioned to complete this very brief sketch of the history of the development of the knowledge of the phenomenon of nitrification and of the organisms to which it is due, the work of Warington, Frankland, Jordan and Richards, Godlewski, Burri, Stutzer, Hartleb, Lawes and Gilbert, Dehérain, and others. The results of their joint labors teach us that in order that nitrification may be active in our fields the soil must be well aerated by stirring or by improving its mechanical condition; that a proper degree of moisture must be maintained, and that excessive acidity must be prevented or destroyed by liming. Indeed, this fact explains much of the beneficial action that is known to attend the application of lime to arable land, and strongly argues in favor of a judicious extension of such use. The work of the Division of Chemistry has shown that the nitrifying organisms from soils from all parts of the country are uniformly highly susceptible to the inimical action of an excess of acids in the medium in which they grow.

INJURIOUS SOIL BACTERIA.

We have still to consider a class of soil organisms which are able under certain conditions to destroy a considerable part of the beneficial work of the organisms mentioned above by decomposing the nitrates contained in the soil and returning the nitrogen in them to the atmosphere in the form of free nitrogen. These organisms are normally present in soils and manures and upon crop residues, but only seem to exert their destructive powers in the presence of such an excess of organic matter and under such definite conditions of aeration as seldom obtain in well-tilled soil of good quality and location. Some alarm was occasioned a few years ago by the announcement by German investigators that all stable manures should be sterilized before applying them to the soil, in order to destroy these denitrifying organisms, but this was not supported by subsequent investigation, nor is it generally regarded as good counsel, as the decomposition of the manure is delayed by such a practice.

CARE OF MICROORGANISMS AS NECESSARY AS CARE OF CROPS.

From the above statements the conclusion follows that the farmer must care for the microscopic organisms growing in his soil, manure pits, and compost heaps, as well as give unceasing attention to the crops which make their appeals directly to his unaided eye. It may be well to add, however, that the best interpretation of the experience hitherto gained is that the farmer should seek to make his soils a highly favorable home for the organisms he wishes to thrive there, rather than attempt to transplant them by "soil inoculation." The rapidity with which most organisms multiply and their extremely wide distribution show that they are sure to follow their favorite food and other conditions of growth sooner or later. It may of course be true in many cases that time will be saved by inoculating the soil or seed with the organism desired.

The same principle should govern endeavors to eliminate organisms which are found to be unfavorable.

AGRICULTURAL CHEMICAL TECHNOLOGY.

Chemistry has done much to promote the progress of agriculture in the line of chemical technology. Good markets for farm products, as has already been stated, are essential to progress and prosperity. Many of the raw materials produced upon the farm enter at once into manufacture, and their value on the market largely depends upon the demand for manufacturing purposes. The principal agricultural chemical industries are starch and glucose manufacture, sugar manufacture, wine making, brewing, distilling, tanning, and fertilizer manufacture. In all these industries chemistry plays a leading part.

STARCH MANUFACTURE.

In the making of starch, chemical science has brought the utilization of the by-products to such perfection that the value of these products alone more than pays the whole expense of manufacture. This fact enables the producers to put the starch upon the market at a price far below what would be possible if chemistry had not come to the aid of the industry. Thus, a vastly greater demand for the raw materials of which starch is made is secured. In Europe potatoes are the principal source of starch, while in the United States indian corn is practically the sole material of economic importance used for this purpose. It is true that in Maine there is a large industry devoted to the manufacture of starch from potatoes, and a few small factories are found in other parts of the country, notably Michigan. The total quantity of starch, however, made from potatoes is extremely small when compared with the product from indian corn. In the manufacture of starch from indian corn chemical problems of the greatest importance are involved. The presence of nitrogenous matter in starch is undesirable, and the separation of the starch in the indian corn from the nitrogenous materials is of the utmost consequence to successful manufacture. By chemical processes, joined with mechanical ingenuity, this separation is now effected in such a way as to leave the nitrogenous matters in a state suitable for animal food. Thus, while, on the one hand, the starch of the indian corn is obtained in a practically pure state, on the other, the waste products are recovered in the form of cattle food of high nutritive value. Again, the germs of indian corn are composed chiefly of oil and protein matter. These are also separated in the process of manufacture, the oil is expressed, and the residue forms a food extremely rich in protein, and valuable both as a cattle food and as a fertilizer. The oil itself, by chemical processes, is prepared for various purposes, among others for the manufacture of a material resembling rubber. All these results have been accomplished by the application in a practical way of the principles derived from chemical investigations.

GLUCOSE MANUFACTURE.

The manufacture of glucose from starch is a chemical process pure and simple. In chemical studies it was early discovered that when starch was submitted to the action of certain ferments and acids it was converted into sugar. This is the principle upon which the manufacture of glucose rests. Formerly sulphuric acid was chiefly employed in producing this hydrolysis. At the present time, however, hydrochloric acid is more commonly used. The starch in the form of a thin paste is subjected to the action of dilute hydrochloric acid under pressure. In a few moments the starch is converted into a mixture of dextrin and dextrose, in which condition it is used for the manufacture of the liquid material known in commerce as "glucose." A longer treatment with hydrochloric acid converts the dextrin into dextrose, and this is the form in which it is used in the manufacture of a solid sugar known as "grape sugar." After the conversion is completed, the hydrochloric acid is neutralized with soda, forming a little common salt, which does not interfere with the use of the glucose and grape sugar for the purposes for which they are used.

SUGAR MANUFACTURE.

In sugar manufacture we see even a more important utilization of chemical knowledge. Especially is this true of the beet-sugar industry. By means of chemical studies the sugar beet has been developed from the common garden beet, containing only 5 or 6 per cent of sugar, to its present condition of a root containing from 12 to 16 per cent. This great improvement has been secured solely by the aid of chemical science conjoined with the highest skill in practical agriculture. In the process of manufacture, however, chemical science has been even more successful. Beet juices, on account of their composition, present greater difficulties in manufacture than the juice of sugar cane. Without the aid of chemical science the present status of beet-sugar manufacture would have been impossible of attainment. Thus, through the exertions of chemistry, an industry has been established which has made a profound impress upon agriculture in general. Regions which are devoted to beet culture are everywhere known as those in which the highest form of scientific agriculture is practiced. Around the beet factory are naturally grouped vast dairy interests, where the cattle are fed upon the pulp from the diffusion batteries. The culture of beets implies the application of those principles of agricultural chemistry which secure an increase of the soil fertility. Every beet field, therefore, becomes a practical experiment station, where the best forms of agriculture are taught. All crops receive the benefits of this high culture, and thus, in these applications of the principles of practical agricultural chemistry, the general welfare of the agricultural interests of the community is secured. Perhaps there is no other instance in chemical technology where the application of scientific principles has proved of such signal advantage to the progress of agriculture.

WINE MAKING.

Wine making rests also largely upon chemical principles. In grapes we find large quantities of sugar combined with organic acids, of which tartaric acid is the chief, coloring matters, tannic principles, etc. The production of wine of fine flavor consists in securing the fermentation of the sugars of this mixture with appropriate ferments and under carefully controlled conditions of temperature. Only through the most careful chemical control are the most favorable conditions maintained. Consciously or unconsciously, the wine maker is a practical chemist, and under the influence of modern research the scientific principles of wine making are very much more firmly established and more easily practiced than they were before the conditions under which wine is produced were thoroughly understood. In wine making chemistry also exercises an important function in the utilization of the by-products. The tartaric acid present in grapes is very valuable in commerce, forming, in combination with potash, the well-known substance cream of tartar, which is so extensively employed in the manufacture of baking powders and for other purposes. By the application of the principles of chemical technology to the residues of the wine press and to the incrustations which form upon the vats the cream of tartar of commerce is secured.

BREWING.

Brewing is also largely a chemical science. The chief problem in the brewing industry is that of fermentation, and the development of fermentation has been due solely to the researches of chemists. In the brewing industry the first object is to convert the starch of the cereal into maltose and subsequently to change the maltose into alcohol by fermentation with yeast. By the researches of physiological chemists, it was discovered that the active principle in the conversion of starch into sugar is an enzymic ferment commonly called diastase, which is developed in barley by germination. This ferment rapidly converts starch into maltose, the conversion often taking place within a few minutes. By the researches of Pasteur and other distinguished chemists, the method of producing pure cultures of yeast was established. It is important, in order to secure a fine flavor to the finished product, that the ferment be as pure as possible. It is thus seen that in the chief problems which underlie the brewing industry chemistry takes a leading part.

DISTILLING.

The industry devoted to the manufacture of alcohol, whisky, and brandy is also chiefly of a chemical nature. The distilling industry naturally follows after the brewing industry. The manufacture of alcohol from starch may be described as the same in both industries. After the alcohol is formed it is separated from the mash by distillation. In spite, however, of the greatest care in the selection of yeasts, several varieties of alcohol as well as of organic acids are formed during the process of fermentation. After the distillation is finished, therefore, the separation of common alcohol from the impurities with which it is naturally mixed becomes a difficult chemical problem. The progress which has been made in this line, however, has been so great as to render the production of pure alcohol on a commercial scale an industrial proceeding of great magnitude. Chemical principles also of the utmost importance underlie the production of whisky and brandy, due to the elimination of objectionable alcohols by means of oxidations produced by storage under proper conditions of temperature and in suitable vessels. The whole process of aging a whisky or brandy or wine rests exclusively upon the proper conduct and control of the chemical reactions which take place.

TANNING.

The hides (at least indirectly) and also the principal part of the materials used in the process of tanning are products of the soil. Chemical technology has shown that in the process of tanning the gelatinous matters of which hides are composed are impregnated with tannic principles in such a way as to change their nature, rendering them insoluble in hot or cold water, resistant to atmospheric influences, flexible, and lasting. All these conditions are obtained by strictly chemical processes which have been carefully worked out. The relations of gelatin to tannin have been made the subject of the most careful chemical research. In like manner the utilization of the tannin-producing forests has been rendered much more economical. Formerly only the bark of the oak, the hemlock, and the chestnut was employed, but chemical science has shown that mixed with the fiber of the wood itself are tanning properties of a high value. In canaigre and other plants, chemical research has discovered sources of tannin that will take the place of tan bark, in the quest of which vast forests have been destroyed. Chemical technology has also taught the method of extracting from the bark and the wood their active principles, thus enabling dealers to transport the tannic principles in a condensed state and at a greatly reduced cost for freights. Almost all the great tanning industries of the country at the present time employ skilled chemists, and in many instances these chemists are directors of the factories.

FERTILIZER MANUFACTURE.

Perhaps chemical technology has rendered agriculture no other service so valuable as that which it has given in the development of the fertilizing industries of the world. The vast deposits of plant foods which occur in South America in the form of nitrate of soda, in Germany in the form of various combinations of potash, and in this country in deposits of mineral phosphates are made useful to agriculture only through the intervention of chemical technology. The earths saturated with nitrates in South America are treated chemically and the fertilizing principle obtained in a condensed form, making their economic transportation possible. The compounds of potash obtained in the mines near Stassfurt are subjected to chemical treatment, whereby the potash salts are concentrated and obtained chiefly in the form of sulphate and chlorid. The vast deposits of mineral phosphates furnish abundant materials which are subjected to treatment chiefly with sulphuric acid, and thus phosphoric acid is secured in a soluble form suitable for absorption by the growing plant. The wastes and offal of the cattle pens and abattoirs are collected and treated chemically and the nitrogenous and other fertilizing materials they contain secured in merchantable shape. Bones are subjected to mechanical and chemical treatment in order to render their phosphoric acid quickly soluble. Chemical technology has even established an intimate bond of union between agriculture and metallurgy. Iron ores that a few years ago were totally unfit for use by reason of the large amount of phosphorus they contained are now converted into the finest steel by new chemical processes which at the same time secure the phosphoric acid in the form of basic phosphatic slags, considered one of the most valuable phosphatic manures in use.

RELATION OF CHEMICAL TECHNOLOGY TO GENERAL AGRICULTURE.

In the above ways, the science of chemistry has offered to agriculture stores of plant food which a few years ago were totally inaccessible and useless. These stores are practically inexhaustible, since chemistry has shown that the atoms of plant food which are thus employed in the nutrition of the plant return after their cycle of life to the mineral state, only again to be made available for human nutrition. Chemistry in its relations to the technology of fertilizing materials has pointed out the way for indefinitely increasing the fertility of the soil and of laying forever the specter of starvation, which has so often been raised to threaten the future of mankind.

It is thus seen that chemical technology, while not directly concerned with the tillage of the fields, has done a wonderful work in establishing agriculture as a scientific profession and assuring its future against the principal dangers which menace it.

The Debt of Agriculture to Chemistry.

The foregoing sketch of the relations of chemical research to the progress of agriculture during the past hundred years presents an outline view of the status of this industry and its debt to science at the close of the nineteenth century. The true composition of the soil and its relations to plant growth are now known. The methods of utilizing plant food and of conserving it for the coming years have been fully established. The principles of plant growth and the chemical changes attending it are understood. The laws of animal nutrition have been experimentally elucidated, and by their application great economy in the use of nutrients is effected. The methods whereby organic nitrogen is prepared for plant food have been revealed, and some of the ways in which atmospheric nitrogen enters into organic combination are marked out. The application of the principles of chemical technology to the elaboration of raw agricultural products has added a new value to the fruits of the farm, opened up new avenues of prosperity, and developed new staple crops.

The closing of the century sees in this country an endowment for agricultural research which excites the admiration of the whole civilized world, and a study of the personnel of the scientific corps shows that fully half the amount expended for strictly scientific investigations has been for chemical studies. We find chemistry intimately associated with nearly every line of agricultural progress and pointing the way to still greater advancement.

When we contrast the condition of agricultural chemical knowledge which now obtains with the nebulous, empirical, and illogical theories which characterized it one hundred years ago, the distance we have traversed seems indeed long; but we should not forget that we are still only on the threshold of knowledge. The achievements of the next century ought to surpass those which the past one looks upon with pride.

To him who writes the story of the progress of agriculture as influenced by chemical research during the twentieth century may come a feeling of pity for the ignorance which now surrounds us; but he will at least accord to our workers the merit of being emancipated from the slavery of opinion and the worship of authority. He will certainly say they were patient, industrious, and truth loving. To the leaders of progress for the next century we commit our unfinished work, confident of their integrity and hopeful of the good which they will bring to mankind.

A REVIEW OF ECONOMIC ORNITHOLOGY IN THE UNITED STATES.

By T. S. Palmer,
Assistant Chief of Biological Survey.

Introduction.

Economic ornithology has been defined as the study of birds from the standpoint of dollars and cents. It deals with birds in their relation to agriculture, horticulture, trade, and sport; it treats of species important to the farmer, the fruit grower, the game dealer, the milliner, and the sportsman; in short, it is the practical application of the knowledge of birds to the affairs of everyday life. The study of the relations of birds to agriculture is as intricate and difficult as it is broad and comprehensive. Its successful prosecution presupposes not only an accurate knowledge of classification, distribution, migration, and habits, but also an acquaintance with the measures which have been adopted for the preservation of useful or the destruction of noxious species. Theoretically, it should be one of the first branches of ornithology to receive attention; in reality, it has been one of the last.

DEVELOPMENT OF AMERICAN ORNITHOLOGY.

The history of American ornithology may be traced back to the middle of the sixteenth century, but for one hundred and fifty years the references to birds consisted of little more than fragmentary notes in the writings of early explorers and colonists. In the eighteenth century several important works appeared, the principal one being Mark Catesby's great work on the "Natural history of Carolina, Florida," etc., published in 1731–1743. One hundred and thirteen species of birds were described and figured, and the plates formed the basis of many of the species described by Linnæus a few years later. Important contributions were also made by Edwards, Forster, Latham, Bartram, Hearne, and Barton. Bartram's "Travels through North and South Carolina," 1791, marked the beginning of the distinctively American school of ornithology, and Barton's "Fragments of the natural history of Pennsylvania," 1799, was notable as the first exclusively ornithological book published in this country.

In the nineteenth century three names, Wilson, Audubon, and Baird, stand out with such prominence that they mark epochs in the development of the science. Wilson's "American ornithology," 1808–1814, laid the true foundation of ornithology in the United States;

Audubon's "Birds of America" and "Ornithological biographies," 1827–1839, occupy a field entirely alone, and Baird's "Birds of North America," 1858, published in conjunction with Cassin and Lawrence, made a great advance in all that relates to classification and nomenclature (the technical side of ornithology), and exerted a wider influence perhaps than any previous work. In the meantime the activity of travelers and explorers had added important contributions. The expeditions of Lewis and Clark across the continent in 1804–1806, of Long to the Rocky Mountains in 1819–20, and of Franklin to the Polar Sea; the travels of Douglas, Nuttall, Townsend, Maximilian, Audubon, and others; and, finally, the expeditions of the Pacific Railroad surveys opened up many new fields and brought to light a host of new birds from previously unknown regions in the West and North. The publication of Baird's work was followed almost immediately by a rapid increase in ornithological literature. The number of workers multiplied, and their contributions covered the whole field, from the brief description of a new species to elaborate faunal lists and comprehensive modern manuals, like those of Coues and Ridgway, which include all the birds of the continent from Mexico to the Pole. In 1883 the organization of the American Ornithologists' Union (an outgrowth of the Nuttall Ornithological Club, formed ten years previously) brought the individual workers in touch with one another and gave a new impetus to North American ornithology. The union prepared a code of nomenclature, which found general acceptance among zoologists, harmonized conflicting systems of classification, and published a new check list of birds. It stimulated research in every branch of ornithology, and by means of its quarterly journal, "The Auk" (now in its seventeenth volume), provided a place of publication and brought together in one series a large number of papers which otherwise would have been widely scattered.

Since the beginning of the century the field of North American ornithology has been extended from the Atlantic States to the Pacific, and from the Mexican boundary to Alaska and Greenland. The list of birds has increased 400 per cent, as shown by the number of species recognized by different authors: Wilson, in 1814, described 278 species; Audubon, in 1844, increased the list to 506; Baird, in 1858, recognized 738; Coues, in 1873, 778 species and subspecies; Ridgway, in 1880, 877; the "Check list" of the American Ornithologists' Union, in 1886, 951; and the additions since made have increased the number to about 1,125.

Compared with the activity in systematic work, the record of economic ornithology seems meager. The labors of American ornithologists were naturally directed at first to the discovery and description of new species and the acquisition of facts regarding their general habits and distribution; little attention was given to economic questions. Many notes concerning the food of birds may be found in the writings of

Wilson and Audubon, but there is little of importance outside of the works of these authors before the middle of the present century. The history of economic ornithology may be conveniently considered under three heads: (1) Investigations as to the value of birds; (2) commercial uses of birds; (3) measures for the destruction, preservation, and introduction of important species.

Investigations as to the Value of Birds.

The practical study of ornithology began to attract attention about 1850, and several papers appeared in the reports of the agricultural societies of Illinois and Ohio, as well as in the reports of the United States Commissioner of Patents. The character of some of these early contributions is indicated by such papers as Le Baron's "Observations on the birds of Illinois most interesting to the agriculturist" (1855), Walford's "Importation and protection of useful birds" (1855), Holmes' "Birds injurious to agriculture" (1857), Kirkpatrick's "Hawks and owls" (1858), and Dodge's "Birds and bird laws" (1865). Between 1860 and 1863 Dr. J. A. Allen prepared a series of twenty-five popular bird biographies entitled "Birds of New England," designed to interest farmers in common birds. In 1864 Elliott published an extended article on "Game birds of the United States," and during the next four years Samuels contributed three papers devoted largely to the birds of New England.

COMMENCEMENT OF INVESTIGATIONS ALONG MODERN LINES.

The first investigation along modern lines seems to have been made by Prof. J. W. P. Jenks, who, in 1858, studied the food habits of the robin and examined a considerable number of stomachs, collected at frequent intervals during the year.[1] Between March and September specimens were collected weekly and some of the time daily. Stomachs taken in March and April contained only insect matter, 90 per cent consisting of the larvæ of crane flies (*Bibio albipennis*). From May 1 to June 21 *Bibio* larvæ disappeared, but were replaced by a variety of insects, including caterpillars, elaterid beetles, and spiders. From late June to October the stomachs contained strawberries, cherries, and other fruits, but after October the vegetable diet was discarded and replaced by grasshoppers and orthopterous insects. The few birds which remained during the winter fed mainly on bayberries (*Myrica cerifera*), privet berries (*Ligustrum vulgare*), and juniper berries (*Juniperus communis*).

By a curious coincidence an experimental investigation of the robin was made in the same year (1858) by Prof. D. Treadwell. Two young birds, caught about June 5, were kept in captivity for the purpose of noting the amount of food eaten and the rate of growth from day to

[1] Trans. Mass. Hort. Soc., 1859.

day. One of the birds died after three days, but the other remained under observation for thirty-two days, when it had attained full size. "The fame of this robin has extended over both hemispheres." Its capacity for worms seemed unlimited. On the fourteenth day the worms eaten numbered 68, and their weight amounted to 41 per cent more than that of the bird, while their length, if laid end to end, would have measured 14 feet. Treadwell estimated that a pair of robins feeding a brood of four young at the rate averaged by this bird would have to collect 250 worms per day—an interesting illustration of the quantity of food consumed during the breeding season.[1]

In 1878 Prof. Samuel Aughey's classical paper, "Notes on the nature of the food of the birds of Nebraska," appeared in the First Annual Report of the United States Entomological Commission. It included observations extending over a period of thirteen years of 90 different species and an examination of more than 630 stomachs. The stomach contents were merely separated into grasshoppers, other insects, seeds, and miscellaneous, and the number of grasshoppers was given in each case. The report was the most extensive contribution to economic ornithology thus far published, and showed that grasshoppers, when abundant, become the principal food of insect-eating birds, and that they are largely eaten even by water birds.

In the meantime two entomologists had published their views on the relative value of birds and predaceous insects as insect destroyers. B. D. Walsh, State entomologist of Illinois, declared in 1867 that unless a bird destroyed at least thirty times as many noxious as beneficial insects it could not be considered a public benefactor.[2] The fallacy of this view was shown by Forbes, in 1880, in his "Interaction of organisms," and later by Weed.[3] In 1873 M. Edouard Perris called attention to the harm that birds might do in destroying parasitic hymenoptera, and stated that the utility of a bird depended on how many injurious insects it destroyed, usually an unknown quantity.[4] Forbes published a translation of this paper[5] seven years later, thus bringing it prominently to the notice of American ornithologists.

A PERIOD OF NOTABLE ADVANCE IN INVESTIGATIONS.

A notable advance was made in 1880 by Prof. S. A. Forbes, who first called attention to the relative value of the three methods of investigation now in general use, namely: (1) Field observation; (2) experiments on wild birds recently caught; (3) examination of stomachs in the laboratory. He also divided the food into three categories—injurious, neutral, and beneficial. Forbes's attention was confined

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[1] Proc. Boston Soc. Nat. Hist., VI, pp. 396-399, 1859.

[2] Practical Entomologist, I[illegible] pp. 44-47, January, 1867.

[3] Proc. Fourteenth Ann. M[illegible]ing Soc. Promotion Agr. Sci., pp. 70-74, 1893.

[4] Bull. Mensuel Soc. Acclim [illegible] Paris. [illegible] 1873.

[5] American Entomologist, I[illegible], pp 69 and 96, 1880.

mainly to thrushes, wrens, and bluebirds, of which he examined 320 stomachs, representing 9 species. His paper on the "Food of birds," printeded in the Bulletin of the Illinois State Laboratory of Natural History in 1880, is a model of thoroughness, and still remains the best report published on the food of the robin. A second paper on "The regulative action of birds upon insect oscillations," published in 1883, was devoted mainly to a discussion of the question whether insectivorous birds neglect their usual food for the sake of other insects which are unusually abundant, and a number of birds were collected during two successive years in an old orchard badly infested with cankerworms. These insects had attracted birds of the most varied character and habits to the orchard. An examination of 146 stomachs, representing 36 species, showed that 35 per cent of the food consisted of cankerworms.

About the same time appeared an elaborate investigation of the "Economic relations of Wisconsin birds," by Prof. F. H. King.[1] This report was chiefly remarkable for the large number of stomachs examined, more than 1,600, representing about 83 species, and the attempt to show graphically the percentage of the various elements of the food. It was the most extensive investigation thus far undertaken, but many species were represented by too small a number of stomachs to furnish satisfactory conclusions, and like Aughey's work in Nebraska, the identifications were rarely carried out in detail.

In Pennsylvania Dr. B. H. Warren has paid much attention to the food of birds, and has published the results of an examination of 2,084 stomachs, chiefly of grackles and birds of prey, in his "Birds of Pennsylvania," 1886. He has given special attention to the economic relations of hawks and owls, and in his reports as State zoologist and his "Enemies of poultry," 1899, has shown the evil results of the Pennsylvania "scalp act" of 1885. To his energy is due much of the credit of exposing the evils of bounty legislation on birds.

The destruction of birds and the causes of the decrease in bird life have been the subject of special study by Hornaday, who published in 1898 an important paper entitled "The destruction of our birds and mammals."[2]

Since 1886 economic investigations have been carried on chiefly with State or federal aid, and comparatively little has been undertaken by private individuals, except along special lines. Reference should here be made to the work of Forbush in connection with the gipsy moth commission of Massachusetts; to the detailed study of the food of the robin by Wilcox, who examined 187 stomachs collected during spring and summer;[3] and also to the studies of Prof. Clarence M. Weed, of the winter food of the chickadee (based on an examination

[1] Wis. Geol. Surv., I. pp. 441–610, 1882.

[2] Second Ann. Rept. N. Y. Zool. Soc., pp. 77–126. 1898.

[3] Bull. 43, Ohio Agr. Expt. Station, pp. 115–129, 1892.

of 41 stomachs) and the habits of the chipping sparrow in feeding its young.[1]

The important researches thus briefly noticed include four investigations on the robin, an examination of 630 Nebraska birds, some 450 Illinois birds, about 1,600 Wisconsin birds, and an investigation of 2,084 birds of prey, grackles, and other species in Pennsylvania, comprising in all more than 5,000 stomachs.

WORK OF THE BIOLOGICAL SURVEY.

ESTABLISHMENT OF THE DIVISION.

One of the most important results of the organization of the American Ornithologists' Union was the impetus given to the study of economic ornithology. Committees on the English sparrow, bird migration, and geographical distribution were appointed at the first meeting, and elaborate investigations were at once begun. The work, however, had been planned on such a large scale that it soon outgrew the resources of the committees, and at the second annual meeting of the union it was determined to present a memorial to Congress to secure an appropriation for continuing it. The relation of birds to agriculture is so intricate and the thorough study of their food so difficult, on account of the amount of time and material required, that investigations of this kind are ordinarily beyond the means of private individuals, and are entitled to Government support. In recognition of the importance of the work, Congress granted an appropriation of $5,000, to be expended under the Division of Entomology of the Department of Agriculture, and on July 1, 1885, established a section of economic ornithology. Under the direction of Dr. C. Hart Merriam, investigations were outlined on a broad scale, to include the "food habits, distribution, and migrations of North American birds and mammals in relation to agriculture, horticulture, and forestry." A year later the section became an independent Division, and in 1896 its name was changed by Congress to the broader title of Division of Biological Survey.

FIRST PUBLICATIONS OF THE DIVISION.

Upon the organization of the Division of Ornithology and Mammalogy, the data collected by several of the committees of the American Ornithologists' Union were turned over to it and formed the basis of its first two bulletins. The notes on distribution and migration of birds were published in 1888 under the title "Bird migration in the Mississippi Valley," and the report on the "English sparrow in America" appeared in the following year. The latter report contained a full account of the sparrow and its introduction into the United States, its depredations on crops, and recommendations for destroying it, or at least preventing its increase. Special attention was called to the desirability of legislation permitting the destruction of the bird. It

[1] Bulls. 54 and 55, New Hampshire Agr. Expt. Station, 1898.

is interesting to note that at the time the bulletin was issued the English sparrow was practically protected by law in twenty-two States, although Ohio and Michigan had taken steps to exterminate it, while now most of the States have withdrawn protection, and Illinois, Michigan, Ohio, and Utah have vainly attempted to destroy the pest under the bounty system.

FUNCTIONS OF THE DIVISION FROM THE STANDPOINT OF ECONOMIC ORNITHOLOGY.

From the standpoint of economic ornithology the Division may be said to have three functions: (1) To determine as accurately as possible the food of birds of economic importance; (2) to act as a court of appeal to investigate complaints concerning depredations of birds on crops; (3) to diffuse the results of its work and educate the public as to the value of birds. In studying birds' food dependence is placed chiefly on examination of stomachs to ascertain what has been actually eaten. Stomachs are collected in different localities at all seasons and in sufficient numbers to show clearly the character of the food. The stomach contents are examined microscopically and identified by comparison with reference collections of seeds and insects. This laboratory examination is supplemented by experiment and field work.

INVESTIGATIONS REGARDING SUPPOSED INJURIOUS BIRDS.

Species popularly considered injurious, such as hawks and owls, the crow, blackbirds, woodpeckers, and blue jays, received attention first. A report on hawks and owls was undertaken by Dr. A. K. Fisher, one on the crow by Prof. W. B. Barrows, assisted by Mr. E. A. Schwarz in the identification of the insect material, while the investigations on the crow blackbird, woodpeckers, and blue jay were made by Prof. F. E. L. Beal.

The destruction of birds of prey in Pennsylvania, following the passage of the "scalp act" of 1885, had attracted widespread interest, and showed the necessity for correcting erroneous views concerning the value of hawks and owls. About 2,700 stomachs of these birds were collected, the contents carefully examined, and the results published in 1893 in a bulletin entitled "Hawks and owls of the United States," illustrated by twenty-six colored plates. Of the 75[1] species and subspecies which occur in America north of Mexico, only 6 were found to be injurious, while several were shown to be beneficial. About the time the work was begun bounties on birds of prey were, or had recently been, offered by Colorado, Indiana, New Hampshire, Ohio, Pennsylvania, Virginia, and West Virginia. At present not only have all the important State bounties been withdrawn (the acts

[1] Ninety species and subspecies are now recognized by the Check List of the American Ornithologists' Union, but if species of accidental occurrence and the less important subspecies are omitted, the number is reduced to about 75. Of these, food examinations of about 45 species have been made by the Division.

still in force are mainly local), but several States have adopted protective measures. New Hampshire and Ohio began with eagles, Rhode Island with fishhawks, and New York and Minnesota with owls. Pennsylvania and Alabama now protect all except the six or seven really injurious species, while during the present year Utah has gone so far as to make it unlawful to kill any hawks or owls. Such changes show the gradual appreciation of the value of these really useful birds.

In the case of the crow, nearly 1,000 stomachs were examined, and the charges of pulling up sprouting corn, of injuring corn in the milk, of destroying fruit, and of destroying eggs of poultry and wild birds were all sustained. But it was found that corn in the milk formed only 3 per cent of the total food, and most of the corn destroyed was waste grain; that the destruction of fruit and eggs was trivial, while, on the other hand, many noxious insects and mice were eaten. The verdict was therefore rendered in favor of the crow, since, on the whole, the bird seemed to do more good than harm.

Similar studies of crow blackbirds (based on about 2,300 stomachs) and woodpeckers (including nearly 700 stomachs), published in 1895, showed that these birds were decidedly beneficial. Only 1 of the 7 species of woodpeckers examined—the yellow-bellied—exhibited any questionable traits, namely, a fondness for the sap and inner bark of trees. Of the 40 or 50 birds, exclusive of hawks and owls, thus far investigated, the English sparrow is the only one which has been condemned.

INVESTIGATIONS REGARDING BENEFICIAL BIRDS.

A number of species usually considered beneficial have also received attention. The Baltimore oriole, meadowlark, cuckoos, red-winged blackbird, rose-breasted grosbeak, cedar bird, robin, bluebird, swallows, and several flycatchers have been studied by Professor Beal, and the shrikes, sparrows, catbird, mocking bird, brown thrasher, and house wren by Dr. Sylvester D. Judd. One of the interesting facts brought out in studying the catbird was the discovery that some birds prefer wild to cultivated fruits, so that the latter may be protected by planting certain berry-bearing shrubs and trees, especially in regions where wild fruit is naturally scarce. The kingbird, frequently condemned as a destroyer of honey bees, was shown to eat very few bees, and these mostly drones. On the other hand, it kills many of the destructive robber flies, and a large proportion of its food is made up of injurious insects, so that it must be regarded as decidedly beneficial. Recent investigations show less favorable results in the case of some other flycatchers, and indicate that the prevailing idea that all insectivorous birds are necessarily very beneficial may require decided modification; and that there are birds which habitually feed on beneficial insects to such an extent as to lower their value to the farmer, if not to place them among the enemies of his crops.

RESULTS OF FOURTEEN YEARS' WORK.

As a result of fourteen years' work the Biological Survey has brought together a collection of about 32,000 bird stomachs, of which some 14,000 have been examined. It has investigated about 100 species (nearly half hawks and owls) and prepared the results for publication in the form of bulletins or special papers. The publications on birds already issued include seven special bulletins,[1] fifteen papers in the Annual Reports for 1886–1893, inclusive, and eight papers in the Yearbooks for 1894–1898. Some of these papers, such as "Seed planting by birds," "Hawks and owls from the standpoint of the farmer," "Birds that injure grain," and "Birds as weed destroyers," deal with general topics of special interest. The investigations on some 30 grain and insect-eating birds were summarized in 1897 for a bulletin entitled "Common birds in their relation to agriculture," and the work of the Division has also formed the basis of two important summaries, one by Miss Florence A. Merriam, entitled, "How birds affect the farm and garden,"[2] the other by Professor Beal, on "Economic relations of birds and their food."[3]

The educational work of the Biological Survey has not been confined to laboratory studies or publications. The Division has prepared exhibits to illustrate the food habits of birds and modern methods of investigation for the expositions at Cincinnati in 1888, Chicago in 1893, Atlanta in 1895, and Nashville in 1897. It indorsed the proposition to establish a "Bird day" in the schools in 1894, and issued a circular on the subject two years later. Ever since its organization it has acted as a bureau of information on all subjects relating to birds or their distribution and habits. In short, it has spared no effort to advance the cause of economic ornithology in every possible way.

COMMERCIAL USES OF BIRDS.

Birds are utilized in a variety of ways. Some species are valuable for food, a few as egg producers, others for plumage for millinery purposes, and still others for their guano. An immense trade has sprung up in game, feathers, and guano, and our markets draw their supplies from all parts of the world. Aside from its purely commercial aspect, this traffic is important in its relation to agriculture. Most game birds are useful to the farmer, and their preservation is important not only because of this fact and on account of their market value, but also for the purpose of protecting smaller insectivorous species which otherwise are likely to be destroyed to supply the

[1] No. 1, English Sparrow, 1889; No. 2. Bird Migration in the Mississippi Valley, 1888; No. 3, Hawks and Owls, 1893; No. 6, Common Crow, 1895; No. 7, Food of Woodpeckers, 1895; No. 9, Cuckoos and Shrikes, 1898; and Farmers' Bulletin, No. 54, Some Common Birds in Their Relation to Agriculture, 1897.

[2] Forest and Stream, XLVII, pp. 103, 123 and 144, 1896.

[3] Proc. Twenty-fourth Ann. Meeting N. J. Hort. Soc., 1899.

increasing demand for game. The millinery trade has already practically exterminated several native species, and as plume birds become scarce insectivorous birds are utilized in increasing numbers. Finally, to the development of the guano trade, agriculture owes much of the advance which has been made in the modern system of intensive cultivation and the intelligent application of fertilizers.

GAME.

Accurate statistics regarding birds and bird products are difficult to obtain, but the increase in this trade has had a marked, and in some cases a disastrous, effect on certain native species. The number of birds annually killed for game in the United States has increased largely with the development of railway systems and the perfection of cold-storage facilities for shipping game to market. Quantities of game are frequently kept in cold storage for months at a time, or even from one season to another, so that our large cities can now receive their supplies not only from neighboring regions but from distant States and even foreign countries; for instance, South American tinamous, shipped from Argentina to London, and then imported into this country, have been sold in the markets of Washington, D. C., having thus been necessarily kept on ice for several months. New York, Baltimore, Boston, Chicago, St. Louis, New Orleans, and San Francisco are all large game centers, and the quantity of birds annually sold in any one of these cities is simply enormous. D. G. Elliot, writing as long ago as 1864, states that one dealer in New York was known to receive 20 tons of prairie chickens in a single consignment, which were estimated to represent 20,000 birds, and that some of the larger poultry dealers sold from 150,000 to 200,000 game birds in the course of six months. "These estimates," he adds, "so far from being exaggerated, are probably far below the true state of affairs, and these, it must be recollected, are but the receipts of a single city. The total number of birds destroyed throughout the country would exceed the credibility of everyone."[1]

The consumption of game to-day is much greater than it was thirty-five years ago, and the effect of such enormous slaughter has become very apparent in the case of several species, as for example, the pinnated grouse, or prairie hen, and the passenger pigeon. The prairie hen (*Tympanuchus americanus*) occurs on the prairies of the Mississippi Valley from Louisiana and Texas, north to latitude 50° in Manitoba, and from northwestern Ohio and southwestern Ontario to central Nebraska and Kansas. In the east its range is rapidly contracting; a few are still found in Kentucky, but the species is rare in Indiana and northwestern Ohio. It usually lays from 11 to 14 eggs in a set, and is considered one of the most prolific of game birds,

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[1] Rept. Comm. Agr., 1864, pp. 383 and 384.

ranking next to the bobwhite in this respect. But in spite of this and the fact that the bird is gradually extending its range westward with the settlement of the country, the species can not maintain its normal abundance in the face of the destructive agents against which it has to contend.

Audubon states that when he first moved to Kentucky (about 1808) prairie hens were very abundant, and could be seen frequently in the farmyards with the poultry and even in the streets of the villages. So little were they esteemed as game that hunters scarcely deigned to shoot them, and they could hardly be sold for more than a cent apiece. A quarter of a century later he remarks that the grouse had practically abandoned the State of Kentucky, and each year their limit of abundance was moving farther westward.[1] A few are still found in the State and in many sections of the prairie region of adjoining States, but they are no longer abundant east of the Mississippi River.

A still more striking case of extermination is that of the passenger pigeon (*Ectopistes migratorius*), which has been reduced almost to the point of extinction except in two or three Northern States. This species formerly ranged over the deciduous forest region of Eastern North America, from the Gulf of Mexico to Hudson Bay, and was remarkable for the enormous numbers which often collected together. To-day its breeding range is restricted to the thinly settled wooded region along the northern border of the United States, chiefly in Michigan and Wisconsin. It was one of the first birds to attract the attention of the early colonists, and references to it may be found as far back as 1630.[2] The enormous breeding colonies and roosts and the great flights, such as that seen by Audubon in 1813, afforded an abundant supply of food, and the birds were slaughtered by the million. Audubon speaks of seeing schooners at the wharves in New York in 1805 that were loaded in bulk with pigeons taken on the Hudson River, and states that the birds sold for only a cent apiece. In March, 1830, he found them so abundant in the New York markets that piles of them could be seen in every direction. He purchased 350 live pigeons at 4 cents apiece, most of which were carried to England. Prof. H. B. Roney has described a breeding colony located near Petoskey, Mich., in 1878, which covered about 100,000 acres of land, and from which it was estimated 1,500,000 dead birds and 80,532 live birds were shipped by rail, and probably an equal number by water. He estimates the total destruction of pigeons in Michigan in 1878 at 1,000,000,000, an estimate probably in excess of the number actually killed.[3]

The passenger pigeon has long since ceased to have any commercial importance; the netting and the slaughter to which it was subjected

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[1] Ornith. Biog., II. p. 491, 1835.

[2] See Merriam's Birds of Connecticut, pp. 93-94, 1877.

[3] Am. Field, X, pp. 345-347.

at its roosts and breeding grounds have almost exterminated it. According to Brewster, the last important nesting in Michigan took place in 1881, a few miles west of Grand Traverse.[1] In the last twenty years the species has decreased so rapidly that its occurrence in any of the States except Indiana, Michigan, Minnesota, and Wisconsin can hardly be considered more than accidental. During the last ten or twelve years a few flocks of a hundred or more have been reported from the following places:

Large flocks of passenger pigeons reported between 1889 and 1899.

Date.	Locality.	Estimated number.	Authority.
1889, September 10	Mackinac Island, Mich	100	White, Auk, X, p. 223.
1894, spring	Hickory, Minn	500	Gault, *ibid.*, XII, p. 80.
1895, May 22	Constableville, N. Y	300	Johnson, *ibid.*, XIV, p. 88.
1897, August 17	Cook, Nebr	100	Deane, *ibid.*, XV, p. 184.
1898, October 3	Ann Arbor, Mich	200	Covert, Recreation. X, p. 304.
1899, April 10	Litchfield, Ohio	150	Scudder, *ibid.*, X, p. 488.
1899, May 15	Norway, Wis	200	Eagan, *ibid.*, XI, p. 221.
1899	Sparta, Wis	500	Dervin, *ibid.*, XI, p. 221.
1899	Montport, Wis	300	Collis, *ibid.*, XI, p. 221.

Smaller flocks or single birds have also been reported from Illinois (Chadwick, 1899; Lake Forest, 1895; Marengo, 1894); Indiana (several points, 1894–1896); Kentucky (Cobb Station, 1898); Maryland (several points, 1893); Massachusetts (Norton, 1889); Missouri (Altie, 1896); New Jersey (Englewood, 1896; Morristown, 1893); Pennsylvania (Potter County, 1892). Although the wild pigeon is now protected by law at all seasons in Michigan and Ohio, it is doubtful whether it can be saved from extinction. Like the bison, it has been sacrificed through wasteful and useless slaughter.

EGGS.

Large colonies of water birds, such as murres, pelicans, gulls, terns, and herons, may be found at certain points along our coasts during the breeding season. The value of these birds has never been properly appreciated, although in certain localities eggs of some species are highly esteemed and find a ready market, as on the eastern shore of Virginia, where eggs of the laughing gull (*Larus atricilla*) are considered a great delicacy and are gathered in large numbers for sale to hotels and private individuals. But in the gratification of this taste there is the same tendency toward extermination, which is manifested in the case of feather collecting.

Scott refers to the extermination of gulls and terns near the mouth of Tampa Bay, Florida, brought about in part by the operation of the

[1] Auk, VI, pp. 285–291, 1889.

COLLECTING ALBATROSS EGGS ON LAYSAN ISLAND, H. I.

[Photograph by J. J. Williams, Honolulu.]

market egg hunters in the early eighties.[1] Sennett, in speaking of the quantities of eggs, chiefly of gulls, terns, and herons, gathered a few years ago along the coast of Texas, says:

There is probably not a port, pass, or bay on the entire coast of Texas whose inhabitants do not regularly devote several days each year to what they term "egging." * * * All eggs from an inch in diameter upward are taken, excepting perhaps those of the pelican, whose eggs are too fishy for any stomach. I have known of boats which came a distance of over 100 miles to gather these eggs, cruising from reef to reef until they secured a good load. For days after the return from these expeditions the shops along the coast expose quantities of birds' eggs for sale, which are disposed of cheaply, according to size. * * * In regard to the profits of the "egging business," I doubt if even the most successful "egger" can make as much money as he could have done had he stuck to his regular and much more praiseworthy occupation.[2]

The eggs of the "arrie" or "Pallas" murre (*Uria lomvia arra*) are collected for food on the Pribilof Islands, in Bering Sea, and H. W. Elliott mentions that on the occasion of his first visit to Walrus Island, in July, 1872, six men in less than three hours loaded a badarrah carrying 4 tons with eggs to the water's edge.

On Laysan, one of the northwestern Hawaiian Islands, the "gooney," or albatross (*Diomedea immutabilis*), fairly swarms. Immense quantities of its eggs are gathered for the use of the employees of the guano company, and possibly some are shipped to Honolulu. Photographs show that the eggs are gathered not only by the wheelbarrow load but by the car load. (See Pl. VI.) Formerly, it is said, the birds were accorded rigid protection by the superintendent of the company, but how long they can survive the recent wholesale removal of eggs is not difficult to surmise.

A still more striking example of wholesale egg collecting, and probably the most important one in the United States from a financial standpoint, is that of the Farallones. These islands, or rather rocks, situated on the coast of California 30 miles west of the Golden Gate, are the breeding grounds of myriads of sea birds, chiefly western gulls (*Larus occidentalis*) and murres, or California guillemots (*Uria troile californica*). For nearly fifty years murre eggs were collected here and shipped to the San Francisco market, where they found a ready sale at from 12 to 20 cents per dozen, a price only a little less than that of hens' eggs. During the season, which lasted about two months, beginning near the middle of May, the eggs were shipped regularly once or twice a week. The main crop was gathered on South Farallone, the principal island, and mainly from the "great rookery" at the west end. The bird lays only one egg, which is deposited on the bare rock. When the season opened, the men went over the ground and broke all the eggs in sight, so as to avoid taking any that were not perfectly fresh. The ground was then gone over every second day, and the eggs were systematically picked up and shipped to market.

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[1] Auk, V, p. 377, 1888.

[2] Science, VII, pp. 199–200, February 26, 1886.

The business was in the hands of Italians and Greeks, who were also engaged in fishing, and although only a dozen or fifteen "eggers" were employed on the islands, the number of eggs gathered was simply enormous. It is said that in 1854 more than 500,000 were sold in less than two months, and that between 1850 and 1856 three or four million were taken to San Francisco. Dr. Heermann states that the value of the traffic was between $100,000 and $200,000, evidently too large an estimate, even at the high price of eggs prevailing at that time. Since then the value of the eggs has declined, and the number has also fallen off considerably. In 1884 there were gathered 300,000; in 1886 about 108,000; while in 1896 the crop was reduced to a little less than 92,000.

The Farallones being a Government light-house reservation, the "eggers" were allowed on the islands only by sufferance. From 1850 to 1880 the Farallone Egg Company remained in almost undisputed sway, but were dispossessed in 1881 by the light-house authorities. Afterwards the keepers employed men to gather the eggs, but in 1897 the attention of the Light-House Board was called to the decreasing numbers of birds, and instructions were promptly issued prohibiting further gathering of eggs for market, thus practically putting an end to the business for the present. Full accounts of the methods employed in this remarkable traffic may be found in the interesting papers of Bryant and Loomis,[1] from which the above facts have been mainly derived.

FEATHERS.

The fashion of wearing feathers and birds on hats has increased to such an extent during recent years as to cause an immense demand for birds and plumes to supply the millinery trade. The saying that a bird which has become fashionable is doomed to almost certain extinction is exemplified by the great decrease in numbers of terns along the Atlantic coast and herons of the Gulf States within the last twenty years. Attention was called to this wholesale destruction by the American Ornithologists' Union in 1886,[2] and the devastation of the Florida heronries and the barbarous methods of the plume hunters were vividly described by Scott in 1887 in a series of papers entitled "The present condition of some of the bird rookeries of the Gulf coast of Florida."[3]

Terns of several species were formerly abundant along the coast from Florida to New England. The common tern (*Sterna hirundo*) and the least tern (*S. antillarum*) bred abundantly on the New Jersey coast, but, according to Stone, both were nearly exterminated about 1883 to supply the millinery trade. As an example of the wholesale destruction of birds, Scott mentions a contract made by two men on Tampa Bay, Florida, for the delivery of 30,000 terns in a single

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[1] Proc. Cal. Acad. Sci., 2d ser., I, pp. 31–36, 1888; VI, pp. 356–358, 1896.

[2] Science, VII, pp. 191–205, 1886.

[3] Auk, IV, pp. 135, 213, 273, 1887.

season. Similar contracts have been made on the coast of Virginia; and from Seaford, Long Island, N. Y., more than 3,000 terns were sent to market during the summer of 1883 by one gunner and his associates, while about the same time 40,000 are said to have been killed on Cape Cod, Mass. The results of such slaughter were swift and sure. An examination of the grounds about the mouth of Tampa Bay and the bars off Pass Agrille, on the west coast of Florida, in the summer of 1888 showed that not a tern of any kind was breeding where countless numbers had nested only a few years before.[1] Of the northern coast, Chapman says in 1895 "this little barren, uninhabited sand island [Gull Island, off Long Island]—only a few acres in extent—and Muskeget Island, off the Massachusetts coast, are the only localities from New Jersey to Maine where the once abundant common tern, or sea swallow, can be found in any numbers. [Each of these islands now has a keeper who is paid to protect the terns.] What an illustration of the results of man's greed and woman's thoughtlessness!"[2]

But the destruction of herons has been, if possible, even worse. The only heron feathers of any value are the nuptial plumes, commonly known as aigrettes, and in order to secure these plumes at their best the birds are killed on the breeding grounds soon after the eggs are laid or the young hatched. As the herons nest in colonies, it is often an easy matter to kill a large number by the use of rifles of small caliber. The American egret (*Ardea egretta*) and the snowy egret (*A. candidissima*) furnish the finest aigrettes, and consequently have suffered most severely; to-day the latter species is the rarest heron in the South.

Scott speaks of finding herons abundant in 1880 at a number of large rookeries on the west coast of Florida, but in 1886 the same breeding grounds were almost deserted or marked by piles of dead and decaying birds. The slaughter which had begun at least two years before was then still under way, and a price had been set on every bird of any value to the plume hunters. One man who had visited Florida for four seasons was employing from 40 to 60 gunners, to whom he furnished supplies and paid from 20 cents to $2.50 apiece for desirable skins, the average price being about 40 cents. Besides the plume birds, such as herons, ibises, and roseate spoonbills, various others—sandpipers, plovers, turnstones, least terns, boat-tailed grackles, gray king birds, and even owls—were killed for the Northern market.[3] "I have heard a 'plume hunter,'" says Chapman, "boast of killing 300 herons in a rookery in one afternoon. Another proudly stated that he and his companions had killed 130,000 birds—herons, egrets, and terns—during one winter. But the destruction of these birds is an unpleasant subject. It is a blot on Florida's history."[4]

[1] Scott, Auk, V, p. 376.

[2] Birds East. N. Am., p. 82.

[3] Auk, IV, pp. 141 and 277.

[4] Birds East. N. Am., pp. 133-134.

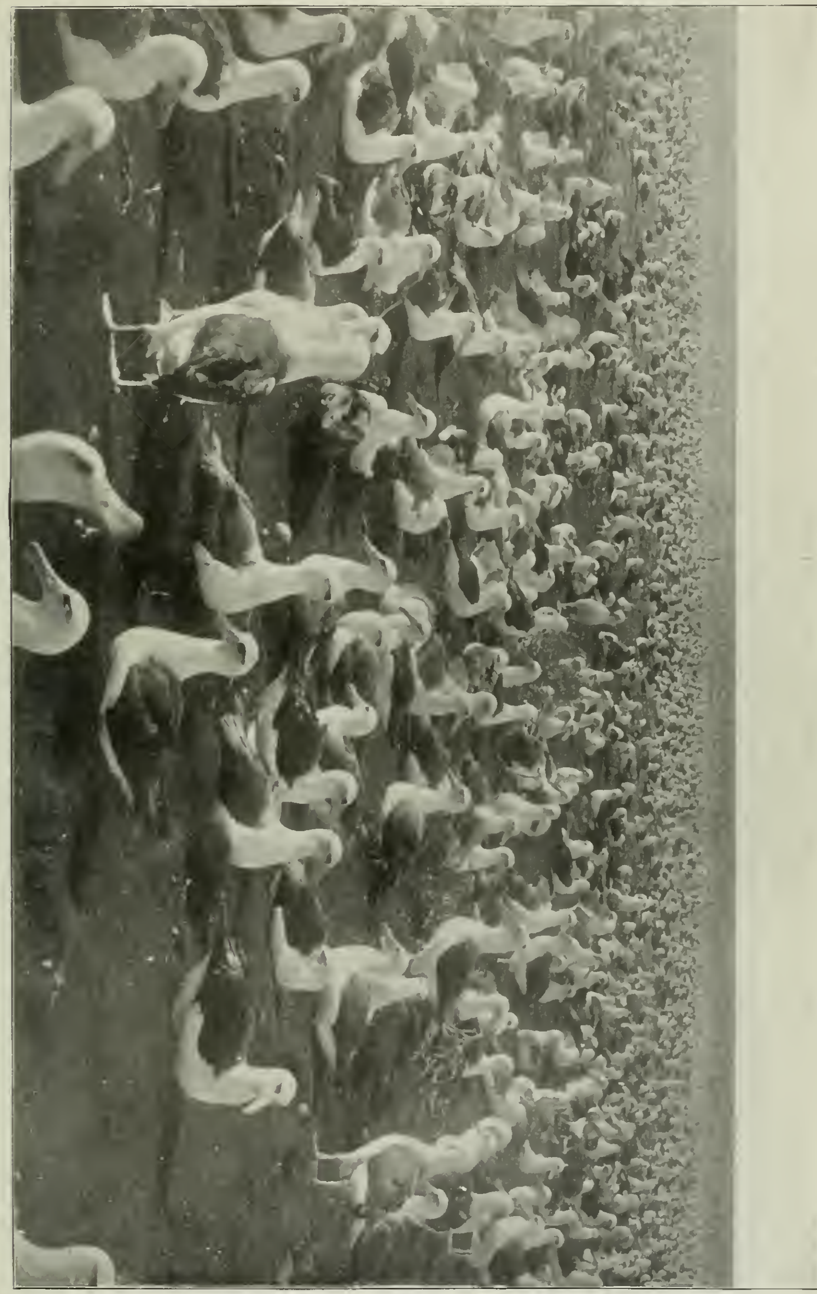
Unfortunately, the demands of the millinery trade are not confined to plume birds and terns or to any particular State, and the slaughter so destructive to the Florida herons is being repeated in less degree in several sections of the country in the case of other birds.

Among the few redeeming features of the feather trade should be mentioned the establishment of a new industry through the introduction of the South African ostrich (*Struthio australis*). The first birds, 22 in number, reached New York in December, 1882, and a few months later were placed on a farm near Anaheim, Cal. In 1899 there were several ostrich farms in southern California, and one each in Arizona, Florida, Texas, and the Hawaiian Islands. Although ostrich farming in the United States has passed through many vicissitudes and is still in its infancy, the important fact has been demonstrated that ostrich feathers can be produced in this country which are equal to the best grades imported from abroad.

GUANO.

Alexander von Humboldt, returning from his extended travels in tropical America in 1804, carried to Europe some samples of bird dung, or guano, and first called attention to the value of the extensive deposits of this substance on the Chincha Islands, off the coast of Peru. The announcement excited little interest at the time, but its importance was realized forty years later, when guano revolutionized methods in agriculture and furnished a new source of revenue for corporations, and even nations, chief among the latter being Peru, which for several years depended largely on the income from the Chincha Island deposits to pay the interest on her national debt. In the early fifties guano became the subject of diplomatic correspondence between the United States and Peru and Venezuela; but the negotiations failing to secure the desired reduction in price of Peruvian guano, deposits were sought elsewhere. Finally, Congress was induced to take action, which resulted in the taking possession by private persons under the protection of the United States of a number of small guano islands in the West Indies and in the South Pacific.

Deposits of the excrement of sea birds occur on rocky islands in various parts of the world in nearly all latitudes; but guano of commercial value is limited chiefly to the rainless regions of the Tropics, usually within a few degrees of the equator. Its fertilizing value lies in the presence of nitrogen, phosphates, and a small amount of potash. Under a tropical sun the excrement dries rapidly and undergoes little change, whereas in moist climates fermentation speedily sets in, resulting in a loss of nearly all the organic matter, while the soluble alkalies and phosphates are leached out. Guano may therefore be divided into two main classes: (1) Nitrogenous, represented by Peruvian guano, which has undergone little change; (2) phosphatic,



ALBATROSSES (DIOMEDEA IMMUTABILIS) ON LAYSAN ISLAND, H. I.

[Photograph by J. J. Williams, Honolulu.]

represented by Baker Island guano, which has lost everything of manurial value except the insoluble phosphate of lime.[1]

Concerning the species of birds to which we owe these valuable deposits, comparatively little accurate information is available, chiefly because most of the islands are mere rocks or reefs, uninhabited and inaccessible, and seldom visited by ornithologists. Laysan Island, in the Hawaiian group, which has been thoroughly explored, is known to be the resort of myriads of albatrosses (Pl. VII), man-o'-war birds, pelicans, tropic birds, gannets, terns, and petrels. Besides these species, shearwaters, gulls, and penguins occur in immense numbers on some of the islands off South America and Africa.

The importance of guano as a fertilizer was recognized by the Peruvians more than three centuries ago. Under the Incas it was held in such high esteem that the deposits on the Chincha Islands were jealously guarded, and the birds which resorted to these rocks were carefully protected. Indeed, it is said that the penalty of death was inflicted on anyone killing the birds near the deposits during the breeding season. Guano was the first of the artificial manures to be used in large quantities, and hence may be said to have brought about the modern system of intensive cultivation. The earliest experiments with it in the United States seem to have been made in December, 1824, with samples from 2 barrels distributed by Hon. John S. Skinner, editor of the American Farmer.[2] Its introduction into England in 1840 was due to Lord Derby. So rapidly did it increase in favor that ten years later the imports amounted to 200,000 tons. It is estimated that this total has since grown to more than 5,000,000 tons. At the inception of the export trade in guano from the Chincha Islands, about 1840, the supply seemed inexhaustible. The deposits covered the three islands in some places to a depth of 90 or 100 feet, estimated at 12,376,100 tons, according to an official survey made by the Peruvian Government in 1853. But so great was the demand for the new and powerful soil stimulant that this enormous quantity has now been practically exhausted.

The extraordinary demand caused a rapid increase in the price. By 1850 it had advanced in the United States to $50 or more per ton, and negotiations were opened with the Peruvian Government in the hope of securing a reduction in the rate. Failing to attain the object in this way, American enterprise began to seek guano elsewhere, and in 1854 the deposits on the Aves Islands, in the West Indies, were taken possession of by a Boston firm. Venezuela promptly seized the islands, but after some correspondence abandoned her claim. Meantime, in September, 1855, the American Guano Company of New York was organized, with a capital of $10,000,000, for the purpose of

[1]Aikman, Manures and Manuring, pp. 296–300, 1894.

[2]American Farmer, VI, pp. 316–317, 1824.

developing the deposits on Baker and Jarvis islands, in the South Pacific; and on August 18, 1856, Congress passed an "act to authorize protection to be given to citizens of the United States who may discover guano,"[1] under which any citizen of the United States was authorized to take possession of and occupy any unclaimed island, rock, or key containing guano, upon filing a notice of such claim and a bond to insure compliance with the requirements of the law. The discoverers of such islands were entitled to exclusive rights to the deposits thereon, but the guano could only be removed for the use of citizens of the United States and at a price not exceeding $8 per ton alongside the vessel, or $4 per ton on the spot. Imports were subject to the laws governing the coasting trade of the United States, and the Government was relieved from the necessity of protecting or retaining possession of any island, rock, or key after the guano had been removed. Thus far, claims have been filed to about seventy-five islands in the Caribbean Sea and the South Pacific, as shown by the following list:

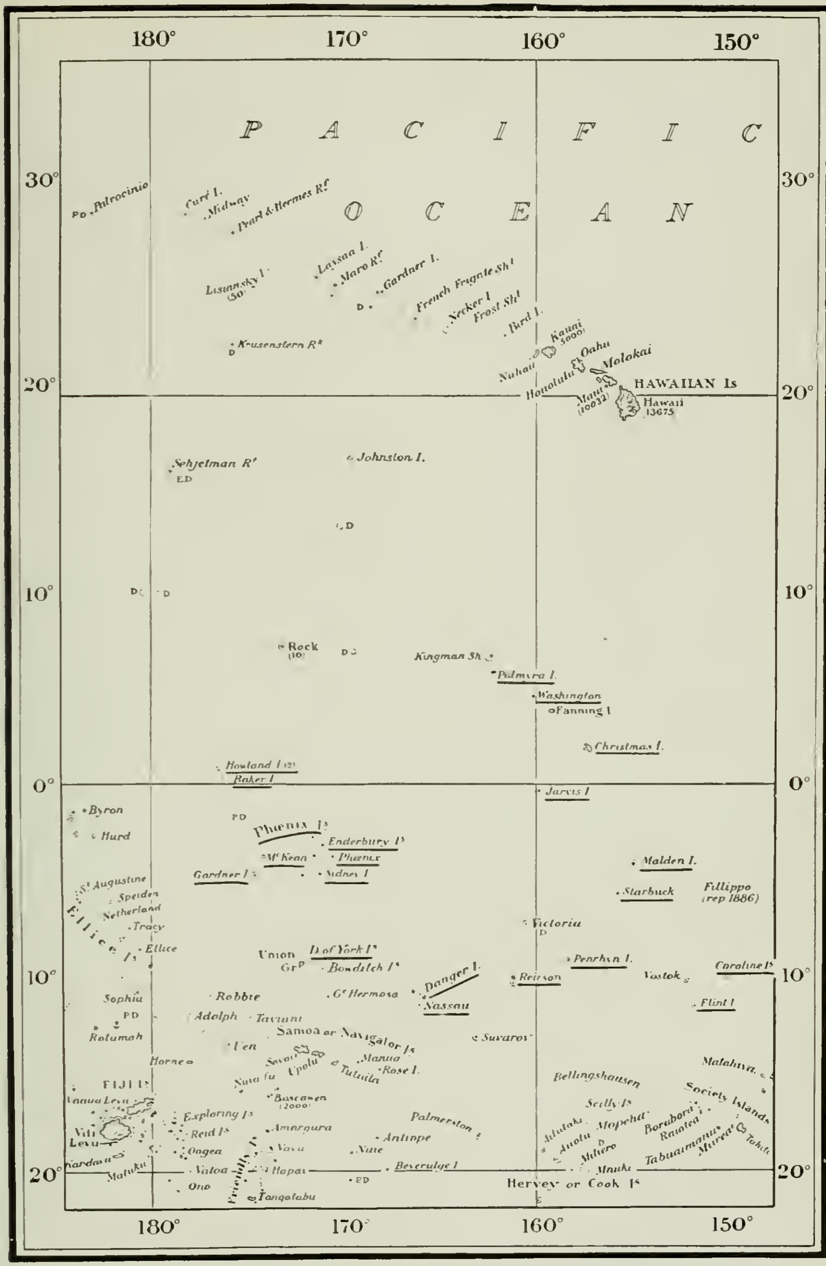
List of guano islands now appertaining to the United States.[2]

[Bonded under act of August, 1856.]

PACIFIC ISLANDS.

Name.	Latitude.	Longitude.	Name.	Latitude.	Longitude.
	° ′	° ′		° ′	° ′
America	3 40 N.	159 28 W.	Groninque	10 00 S.	156 44 W.
Anne	9 49 S.	151 15 W.	Howland, or Nowland	0 52 N.	176 52 W.
Baker, or New Nantucket	15 N.	176 30 W.	Humphrey	10 40 S.	160 52 W.
Barber	8 54 N.	178 00 W.	Jarvis	0 21 S.	159 52 W.
Barren, or Starve	5 40 S.	155 55 W.	Johnston	----------	----------
Bauman	11 48 S.	154 10 W.	Kemn	4 41 S.	173 41 W.
Birnie	3 35 S.	171 39 W.	Lideron	11 05 S.	161 50 W.
Caroline	9 54 S.	150 07 W.	Low	9 33 S.	170 38 W.
Christmas	1 58 N.	157 10 W.	McKean (Phœnix group)	3 35 S.	174 17 W.
Clarence	9 07 S.	171 40 W.	Mackin	3 02 N.	172 46 W.
Dangerous	10 00 S.	165 56 W.	Malden	4 00 S.	155 00 W.
Dangers Rock	6 30 N.	162 23 W.	Mary Letitia	4 40 S.	173 20 W.
David	40 N.	170 10 W.	Mary	2 53 S.	172 00 W.
Duke of York	8 30 S.	172 10 W.	Mathew	2 03 N.	173 26 W.
Enderbury (Phœnix group)	3 08 S.	171 08 W.	Nassau	11 30 S.	165 30 W.
Farmer	3 00 S.	170 50 W.	Palmyra	5 48 N.	162 20 W.
Favorite	2 50 S.	176 40 W.	Penrhyn	8 55 S.	158 07 W.
Flint	10 32 S.	162 05 W.	Pescado	10 38 S.	159 20 W.
Flints	11 26 S.	151 48 W.	Phœnix	3 40 S.	170 52 W.
Frances	9 58 S.	161 40 W.	Prospect	4 42 N.	161 38 W.
Frienhaven	10 00 S.	156 59 W.	Quiros	10 32 S.	170 12 W.
Gallego	1 42 N.	104 05 W.	Reirson	10 10 S.	160 53 W.
Ganges	10 59 S.	160 55 W.	Rogewein	11 00 S.	156 07 W.
Gardner (Phœnix group)	4 40 S.	174 52 W.	Samarang	5 10 N.	162 20 W.
			Sarah Anne	4 00 N.	154 22 W.

[1] 11 Stat. L., 119. [2] From data on file in the Treasury Department.



PRINCIPAL GUANO ISLANDS IN THE PACIFIC OCEAN (BONDED UNDER ACT OF 1856).

[From Chart 923 of the United States Hydrographic Office. Names of bonded islands underlined.]

List of guano islands now appertaining to the United States—Continued.

PACIFIC ISLANDS—Continued.

Name.	Latitude.	Longitude.	Name.	Latitude.	Longitude.
	° ′	° ′		° ′	° ′
Sidney (Phœnix group)	4 20 S.	171 00 W.	Walker	3 58 N.	149 10 W.
Starbuck, or Hero	5 25 S.	155 56 W.	Washington, or Uahuga	4 40 N.	160 07 W.
Staver	10 05 S.	152 15 W.			

WEST INDIES.

	° ′	° ′		° ′	° ′
Anchor Key	14 18 N.	80 08 W.	North Rocks	14 20 N.	80 26 W.
Aves	15 40 N.	63 37 W.	Pedro Keys	17 00 N.	77 52 W.
Booby Key	14 11 N.	80 30 W.	Petrel	15 52 N.	78 33 W.
Great and Little Swan	17 23 N.	83 50 W.	Quito Sereno	14 30 N.	81 07 W.
Morant Keys (Northeast, Sand, Savanna, Seal)	17 26 N.	77 55 W.	Roncador	13 33 N.	80 03 W.
Navassa	18 10 N.	75 00 W.	Serrana Key	14 15 N.	80 24 W.
North Keys	14 25 N.	80 20 W.	Serranilla Keys (East, Middle, Beacon)	15 20 N.	79 40 W.
			Triangle Keys	14 20 N.	80 05 W.

Fifty-four of these islands are in the Pacific Ocean (see map, Pl. VIII), the remainder in the Caribbean Sea or the Gulf of Mexico. Of the Pacific islands, Baker and Jarvis were bonded in 1856, Howland in 1858, Barren, Christmas, Enderbury, Johnston, McKean, Malden, and Phœnix in 1859, and the others in 1860. The Pacific islands[1] are situated between longitude 150° and 178° W., the most northern being the Johnston Islands, latitude 16° 53′ N.; the most southern, Bauman, latitude 11° 48′ S. Most of them are between the Society and Hawaiian islands, and are chiefly small coral reefs, a mile or two in length, almost entirely destitute of vegetation. One of the most northern guano deposits, which has been successfully developed, is that on Laysan, a small island 3 miles long by 2½ broad, in latitude 26°, which has recently been acquired through the annexation of Hawaii.

As would naturally be supposed, the extent and value of some of the deposits were at first greatly exaggerated, while others proved to have little value, and, as in the case of the Alacran Rocks, in the Caribbean Sea, were afterward abandoned. In an interesting article on the Pacific guano islands, Hague, who had visited a number of them, states that the first cargoes of guano brought from the Johnston Islands proved to be sand; that samples of guano from Christmas Island were chiefly coral sand, and that the deposits on Starbuck, or Hero, consisted of hydrated sulphate of lime. Some of the islands are covered with vegetation, and hence unsuited for the deposition of guano, while others, such as David, Farmer, Favorite, Flint, Samarang, Sarah Anne, and Walker, Hague considered as probably nonexistant, at least in the

[1] Except Gallego, which is in the eastern Pacific in longitude 104° 05′ and northwest of the Galapagos Islands.

positions usually assigned them on charts.[1] Still, during the thirty years from 1869 to 1898, 283,871 tons of guano, valued at $3,229,832, were brought from the islands appertaining to the United States. The production was very irregular, varying from a minimum in 1890 of 1,176 tons, worth $9,577, to a maximum in 1878 of 17,930 tons, valued at $211,239. The returns for each year are shown in the following table:

Guano brought from islands appertaining to the United States for the years ending June 30, from 1869 to 1898, inclusive.[1]

Year.	Tons.	Value.	Year.	Tons.	Value.	Year.	Tons.	Value.
1869	15,622	$253,545	1880	12,795	$147,051	1891	15,857	$101,918
1870	17,068	392,172	1881	16,883	179,882	1892	4,288	26,032
1871	14,154	240,235	1882	15,249	160,016	1893	4,376	26,256
1872	4,209	60,865	1883	7,873	92,130	1894	5,137	31,190
1873	11,014	161,690	1884	9,333	106,431	1895	8,082	48,164
1874	6,877	100,345	1885	12,100	86,166	1896	6,929	37,374
1875	7,269	122,012	1886	5,770	38,839	1897	5,310	31,860
1876	14,785	192,972	1887	8,226	55,671	1898	4,562	27,372
1877	6,060	79,822	1888	5,765	41,226	Total	283,871	3,229,832
1878	17,930	211,239	1889	10,439	72,643			
1879	8,733	95,137	1890	1,176	9,577			

[1] Data furnished by the Bureau of Statistics, Treasury Department. The returns for 1889 to 1893 are published in "Commerce and Navigation of the United States," p. 690, 1899.

Besides the guano deposits belonging to the United States, there are others in various parts of the world, among which may be mentioned those along the coast of Lower California, on the Galapagos, and, the most important of all, the Chincha Islands in latitude 13° 38′ S., Guanape, Lobos, and others belonging to Peru. Valuable deposits have been found along the coasts of Venezuela, Colombia, Ecuador, and Bolivia. Guano has also been obtained from Shark Bay and Swan Island, Australia; Algoa Bay and Saldanha Bay, Cape Colony; Ascension and Ichaboe islands, off the west coast of Africa, and Kuria Muria, on the Arabian coast. Some of the best deposits have now been exhausted; those which remain are expensive compared with the better artificial fertilizers now in use; but a small amount of guano is still brought from some of the islands and imported from abroad, a reminder of the important trade of forty or fifty years ago.

Measures for the Destruction, Preservation, and Introduction of Birds.

A review of the progress of economic ornithology would scarcely be complete without some reference to the attempts which have been made to destroy injurious birds or to increase beneficial species. Naturally, attention was first directed to the damage done by birds to crops, and bounties were paid for the destruction of the marauders. Later, as the

[1] Am. Journ. Sci., XXXIV, pp. 224–243, 1862.

country became settled and the value of birds better appreciated, attempts were made to protect useful species, and also to introduce other species that were thought desirable. The subject may therefore be considered under three heads: (1) Measures for the destruction of birds—bounty laws; (2) measures for the protection of birds—game laws; and, (3) introduction of foreign birds.

MEASURES FOR THE DESTRUCTION OF BIRDS—BOUNTY LAWS.

Efforts have been made since colonial days to exterminate certain birds considered injurious to agriculture. The early settlers, seeing their crops attacked by crows, blackbirds, and ricebirds, undertook measures for bird destruction long before they thought of bird protection. Among the various relief measures were the curious scalp-tax acts, which were intermittently in force in Virginia for more than seventy years subsequent to 1734, and which required a certain number of bird scalps each year in lieu of taxes. In most localities, however, the apparently simple expedient of drawing on the county or State treasury for the payment of rewards was more popular and more generally adopted. Sixteen or more States (all but two east of the Missouri River and north of latitude 36°) have waged a desultory warfare against crows, blackbirds, hawks, owls, certain fish-eating birds, and English sparrows. Crow bounties have been offered in eight States, mainly along the Atlantic seaboard; hawk bounties in ten, chiefly in the Middle States and in those along the Great Lakes; premiums on blackbirds in Minnesota and New Jersey; on fish-eating birds in Utah, and on sparrows in Illinois, Michigan, Ohio, and Utah.

Until recently depredations on grain crops were the main cause of hostility to birds; and the crow was the principal object of attack down to the latter part of the present century. In 1805 a crow-scalp tax was in force in Virginia, under which taxpayers in five counties were required to deliver three crow scalps annually or pay a penalty of 4½ cents for each missing scalp. In 1826 a premium of 8 cents on crows was paid by some of the counties of Virginia, and two years later by the whole State. Meantime, Delaware had authorized the creation of a crow-bounty fund in Newcastle County as early as 1810, and New Hampshire had established a premium of 12½ cents on crows in 1817–1819. Some years later New Hampshire reestablished the rewards, and subsequently offered premiums of 10 cents in 1829, 1832–1835, and 1849–1851. Maine followed next with an 8-cent bounty, which was in force from 1830 to 1834. The only recent crow bounties of consequence are those of New Hampshire (1881–1883) and Maine (1889–1891)—10 cents in each case.

From the earliest colonial times down to 1875 crows, blackbirds, and bobolinks, or ricebirds, had been the main, if not the only, subjects of adverse legislation, but in that year Delaware established the precedent of paying premiums on hawks and owls by offering 50 cents for all species except "fishhawks and mouse owls." These hawk bounties, which were very popular during the succeeding fifteen years, have probably done more harm than any others. In 1877 Delaware's example was followed by Colorado with an act offering a 25-cent bounty on hawks (in force until 1885) and by New Hampshire with one offering a 20-cent bounty (in force until 1881). West Virginia followed in 1881, Indiana in 1883, and Virginia in 1884. Finally, in 1885, Pennsylvania passed its famous scalp act, which resulted in such large expenditures and such glaring frauds that it attracted widespread attention, and was repealed eighteen months later. Since then hawk and owl bounties have been far less popular, and the acts which still remain on the statute books of three or four States are practically dead letters, being enforced in only a few localities.

In 1887 attention was turned to the English sparrow as a legitimate subject for bounty legislation. Michigan began by paying 1 cent apiece for sparrows, and two years later increased the amount to 3 cents. Utah offered one-fourth of a cent apiece and Ohio 10 cents per dozen in 1888, and both States doubled their rewards in 1890. Illinois has paid 2 cents since 1891 on all English sparrows killed in December, January, and February. In 1896 Utah increased its bounty, allowing 1 to 3 cents, and established a rate of 5 cents per dozen on eggs. Sparrow bounties are still maintained in these four States, and have resulted in large expenditures; but they have not exterminated the English sparrow or even caused a perceptible diminution in its numbers except in a few localities. On the other hand, these bounties have caused the destruction of a large number of native sparrows, which have been killed for the sake of the rewards.

A dangerous precedent has recently been set by Utah in placing premiums on fish-eating birds, such as fishhawks, herons, mergansers, pelicans, and loons, in the interest of owners of fish ponds and hatcheries. The act has not been in force long enough to have much effect, but experience in Europe has shown the abuses to which such laws are subject and the evils in which they are likely to result.

The following table contains a list of the principal bounty laws on birds which have been in force during the century; local acts, such as the township bounties in Michigan, and the special county bounties in Maryland, Virginia, and one or two other States, are omitted:

Principal bounty laws on birds in force from 1800 to 1899.

State.	In force.	Species.	Remarks.
Colorado	1877-1885	Hawks	25 cents.
Delaware	1810	Crows	Newcastle County.
	1847-1852	do	4 cents, March to September.
	1852-1873	do	4 cents.
	1875-1877	Hawks and owls	50 cents (fishhawks and "mouse owls" excepted).
Illinois	1891-1899	English sparrows	2 cents, December to February.

Principal bounty laws on birds in force from 1800 to 1899—Continued.

State.	In force.	Species.	Remarks.
Indiana	1883-1899	Hawks and owls	Not exceeding $2 (sparrow hawks and screech owls excepted).
Kansas	1889	Crows	Crawford County.
Maine	1830-1834	do	8 cents.
	1889-1891	do	10 cents, April to October.
Maryland		Crows and hawks	
Michigan	1869		Township bounties authorized.
	1887-1899	English sparrows	1 cent; 1889, 3 cents; 1895, 2 cents; November to March since 1893.
Minnesota	1885	Blackbirds	
	1887	do	10 cents per dozen, April to June; 5 cents, July to October.
New Hampshire	1817-1819	Crows	12½ cents.
	1829	do	10 cents, April to June.
	1832-1835	do	10 cents, March 20 to July 20.
	1849-1851	do	10 cents, April 15 to June 15.
	1877-1881	Hawks	20 cents.
	1893-1897	do	25 cents.
New Jersey		Blackbirds, crows	
Ohio	1881-1882	Hawks	50 cents.
	1882-1883	Hawks and horned owls.	50 cents ("hen, chicken, or bird hawks" only).
	1888-1899	English sparrows	10 cents per dozen; since 1890, 20 cents per dozen.
Pennsylvania	1885-1887	Hawks and owls	50 cents.
Utah	1888-1899	English sparrows	¼ cent: 1890, ½ cent; 1896, 1 to 3 cents, eggs, 5 cents per dozen.
	1896-1899	Fishhawks, herons, fishducks, loons	10 to 25 cents; since 1897, 25 cents.
Virginia	1826-18—	Crows	8 cents; 5 counties in 1826; general in 1828.
	1849-18—	Blackbirds, crows	
	1884-1899	Chicken hawks and owls.	50 cents (screech owls excepted).
West Virginia	1881-18—	Hawks and owls	

It has been deemed expedient to review this legislation in detail in order to correct the misapprehension that bounty laws are few in number or unimportant. More than forty such laws on birds have been in force during the century, but, besides the Pennsylvania scalp act and a few others, very little information is accessible concerning them. There is still a general demand for bounties on certain birds, as taxpayers ordinarily know little about the cost or the results of such legislation.

Though the average bounty law seldom remains in force more than two or four years, it may prove a costly experiment and do much harm. Maine spent more than $12,000 in her two attempts at crow extermination in 1830–1834 and 1889–1891, Illinois more than $55,000 for English sparrows in 1891–1896, Michigan about $61,800 for English sparrows in 1887–1895, and Pennsylvania about $90,000 for hawks and owls in 1885–1887. Altogether it is safe to say that the systematic destruction of birds in this country during the century has cost more than $250,000, and most of this money has been spent by half a dozen States during the last fifteen years. Since the exposure of the evils of the Pennsylvania scalp act there has been a tendency to repeal bounties on useful birds of prey, and so far as possible, to provide against fraud. Premiums on crows and blackbirds have been practically abandoned, and almost the only important ones still in force are those on the English sparrow.

MEASURES FOR THE PROTECTION OF BIRDS—GAME LAWS.

It was said some years ago that the United States had done less for the protection of its birds than any other civilized country. If this is still true, it certainly is not because of lack of legislation, for nearly all the States have enacted game laws, and frequently changed them as their defects have become apparent. Statutory law is notoriously erratic and unstable, and with forty-eight States and Territories, each attempting to protect its game in its own way, confusion has naturally arisen. Protective measures have rarely, if ever, fulfilled expectations, and consequently game and insectivorous birds have continued to decrease. Federal legislation has been advocated as the only remedy, but its feasibility is questionable, since the jurisdiction of Congress in ordinary cases extends only to the Territories and Government reservations.

The need of protective measures has long been recognized, and although the uniformity attained by other countries has not been secured in the United States, definite progress has been made, as will be seen from the following brief review: In the present century Massachusetts, as early as 1818, enacted a law for the preservation of game birds; Virginia in 1832 prohibited the killing of wild fowl at night on the water and forbade the use of swivel guns; in 1850 Connecticut and New Jersey protected insectivorous birds; and in 1857 Ohio passed a comprehensive law protecting both game and insectivorous birds and eggs of all species, and prohibiting the sale of game birds during close seasons. By 1864 similar laws were in force in all the States south to Maryland and west to Minnesota, excepting West Virginia and Indiana, and also in California. Several of these acts related solely to game birds, and those of Illinois and Maryland were enforced only in certain counties.[1] At the present day practically all the States and Territories endeavor to protect game, and most of them extend protection to insectivorous birds.

CRITICISM OF GAME LEGISLATION.

Game laws have suffered in popular estimation because they have not been systematically enforced; because, as sometimes alleged, they

[1] Dodge, Rept. Comm. Agr., pp. 442–446, 1864.

are enacted for selfish ends, and because they lack stability and uniformity. The enactment of a game law is only a beginning, and unless some one is charged with seeing that its provisions are carried out, it is almost certain to be a failure; nor can it be entirely successful unless supported by public sentiment. The appointment of salaried game wardens has overcome the first difficulty to some extent.

Credit for much that has been accomplished in protective legislation is due to sportsmen and game associations, but their efforts have not always been appreciated, and have even been misconstrued from the belief that other interests have been overlooked. The relation of the sportsman to the farmer was aptly stated in the State senate report on the Ohio game bill of 1861, as follows:

> The genuine and honorable sportsman is the friend and ally of the agriculturist. He will be found always ready to protect birds which are useful, destroy the rapacious and hurtful, to prevent trespasses, and enforce the laws.[1] * * * The pursuit of game can not be prevented, and it is useless to attempt it. It should be regulated, and for this purpose the highest skill and knowledge of the habits of birds and wild animals should be employed, the most reasonable and perfect rules established by statute, and all should unite in their rigid enforcement. Any other system will result in disappointment and failure.

The principles on which such statutes should be based were defined as (1) protection of useful birds, other than game, at all seasons; (2) protection of game birds in such manner as to promote their reasonable increase; (3) withdrawal of protection from species of doubtful value; (4) use of well-known names in the statutes to avoid confusion.[2] Another common criticism is that game laws are subject to frequent change. This is, unfortunately, true, but there have been notable exceptions, such as the act recently repealed in the District of Columbia, which remained in force twenty-one years, and the Indiana and Louisiana statutes of 1881 and 1877, respectively, which are still in force. However, permanency without effectiveness is of little value.

EFFORTS AT UNIFORMITY IN GAME LAWS.

Repeated efforts have been made to bring about greater uniformity in the various State laws, including those protecting insectivorous birds. The International Association for the Protection of Fish and Game, organized in May, 1875, and comprising representatives from thirty-eight States and Territories and Canada, prepared in 1877 a simplified code of cooperative laws for presentation to State legislatures, but then allowed the matter to drop. Between 1890 and 1896 half a dozen conferences of State commissions were held, but they

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[1] This relation is exemplified by the Connecticut Association of Farmers and Sportsmen for the Protection of Fish and Game, which has for its objects not only the preservation of game and the enforcement of game laws, but also the protection of farmers against trespassers and marauders who tear down fences or injure stock. This association has been in existence ten years.

[2] Collins, Fifteenth Ann. Rept. Ohio Board Agr. for 1860, pp. 383, 390, 1861.

accomplished little of permanent value, although at the Saratoga meeting of 1896 no less than thirteen States were represented. In the following year the "Hallock Code" of cooperative legislation was advocated by Mr. Charles Hallock. This scheme divides the United States into three "concessions"[1] (a northern and southern, comprising States, respectively, north and south of latitude 36° 30′ and east of the Rocky Mountains; and a Pacific, including the region west of the Rocky Mountains), in each "concession" the laws to be as uniform as possible, the open seasons identical, and protection to be given insectivorous birds, but withheld from blackbirds, bobolinks, crows, hawks, owls, cormorants, pelicans, and English sparrows.[2]

To a certain extent this idea was carried out by a convention of game wardens and delegates from six Northwestern States held at Chicago in February, 1898, which drafted a bill for the protection of birds and game and agreed to urge its adoption by the respective State legislatures. This bill was enacted by Illinois in 1899.

As an illustration of the present lack of uniformity in game laws and the desirability of some such expedient as that provided by the Hallock Code, the accompanying diagram (fig. 3) has been prepared, showing the months in which woodcock (*Philohela minor*) may be killed in the United States. It will be noticed that twelve States have no protective laws for this species, so that the birds can be killed at any season; that while some States, like Michigan and North Dakota, limit the open season to six weeks, others extend it to six months or more; and that in the South where the birds winter and begin to breed early and thus need protection most, protective measures are least effective. The States are arranged in two groups, as suggested in the Code.

SPECIAL RESTRICTIONS.

Game laws, pure and simple, when properly enforced, may be very effective, as is well shown in the increase of such resident birds as quail and introduced pheasants. Both species are occasionally protected by close seasons of several years' duration, and the open seasons are usually short, that for quail averaging scarcely more than two or three months. There seems to be a general impression that migratory birds are so abundant that they require less protection, and hence the open seasons for them are usually longer, those for ducks ordinarily being five months or more. The result is becoming very obvious in the recent marked decrease of these birds. It is interesting to note that forty years ago the same plea was made regarding the passenger pigeon, now practically exterminated. In a discussion of the Ohio law of 1861 it was said the bird needed no protection.

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[1] "We call it 'concession,' because it is based on compromise and reciprocity."—HALLOCK.

[2] Address before the National Game, Bird, and Fish Protective Association, 1897 (see Western Field and Stream, I, pp. 232–234, 1897).

The passenger pigeon needs no protection. Wonderfully prolific, having the vast forests of the North as its breeding grounds, traveling hundreds of miles in

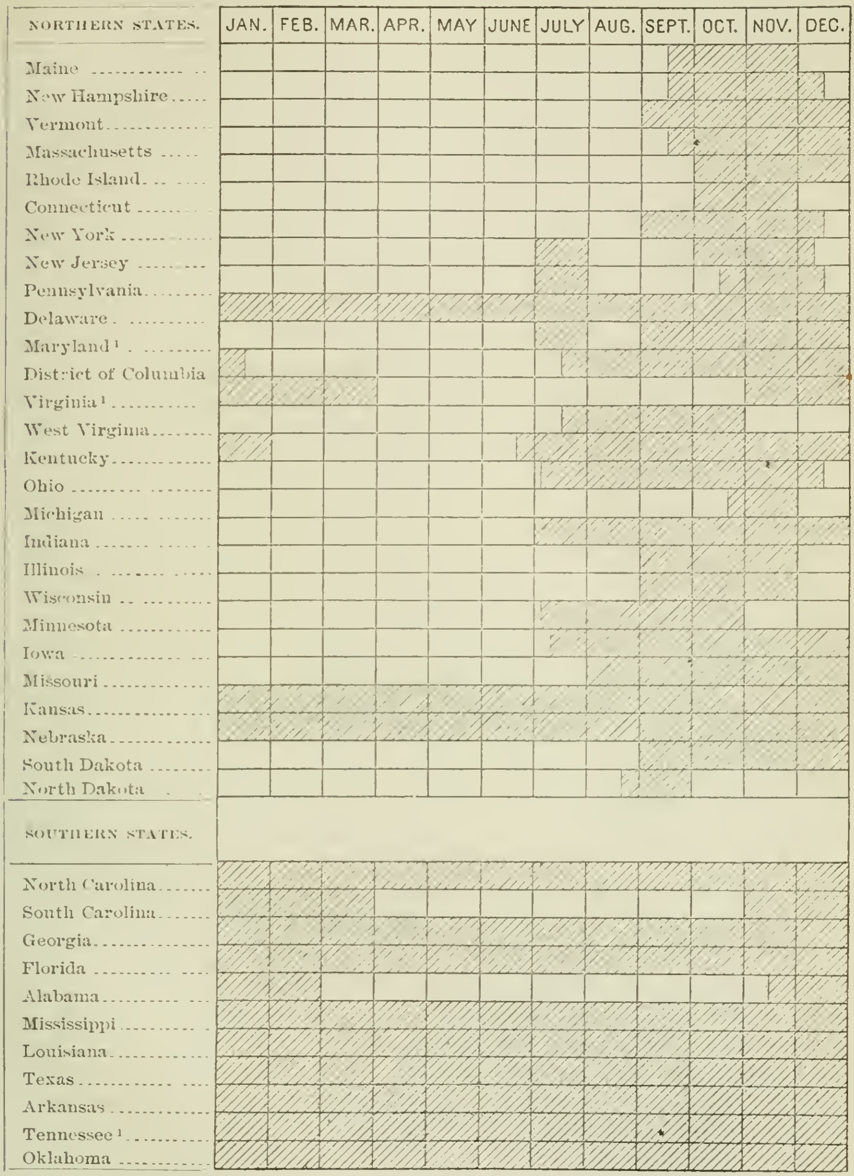

FIG. 3.—Diagram illustrating lack of uniformity in game laws, as shown by laws protecting woodcock (*Philohela minor*) in force in 1899: The unshaded area shows the months when woodcock are protected; the shaded area, the open seasons when shooting is permitted by law.

search of food, it is here to-day and elsewhere to-morrow, and no ordinary destruction can lessen them, or be missed from the myriads that are yearly produced.

[1] Local regulations in some counties provide a different season from that fixed by State law.

* * * The snipe, too, like the pigeon, will take care of itself, and its yearly numbers can not be materially lessened by the gun. The wild goose does not, perhaps, need general protection, though if any linger here till near breeding time they should be spared.[1]

The chief causes of the decrease in game birds are spring shooting, cold-storage traffic, and sale (during the close season) of birds imported from other States. Of late years attention has been directed toward the markets as the chief factor in game destruction, and in order to prevent undue slaughter, the traffic in game has been restricted more closely. Since the constitutionality of nonexport laws was established by the Supreme Court in 1896,[2] nonexport clauses have been quite generally incorporated in game laws, and the shipment of game from one State to another is now restricted or prohibited in more than half the States. Subjecting cold-storage rooms to inspection has been advocated, and laws limiting the quantity of game that may be killed in a day or a season were enacted by Iowa, Minnesota, and Pennsylvania in 1897, and Colorado in 1899. Killing game for sale was prohibited by law in Tennessee in 1889, and in Iowa and Pennsylvania in 1897. It has even been suggested that the sale of game should be prohibited at all seasons. This suggestion, advocated in 1894,[3] seems to have met with some favor, for it was incorporated in the laws of Kansas and Vermont two or three years ago, and has been taken up by the League of American Sportsmen.

The necessity for restricting the list of game birds is still very urgent in certain States. In the markets of New Orleans everything that has feathers seems to be regarded as legitimate game. In some States robins, flickers, meadowlarks, and reedbirds are important items of game, and in California, where true reedbirds do not exist, no less than a dozen species of native sparrows and finches, masquerading under the name of reedbirds, have been identified in the markets of San Francisco. This difficulty is met by the "Act for the protection of birds," proposed early in 1886 by a committee of the American Ornithologists' Union, which limits game birds to the Anatidæ—swans, geese, and ducks; Rallidæ—rails, coots, and gallinules; Limicolæ—plovers, snipe, woodcock, sandpipers, and curlew; and Gallinæ—turkeys, grouse, pheasants, and quail. Species not included in these four groups are protected at all seasons, but provision is made for collecting specimens for scientific purposes. This act was practically adopted by New York in 1886, by Indiana in 1891, and by Illinois in 1899. With its exact definition of game birds and its protection of all other species, it does away with the difficulties attendant upon the enforcement of laws protecting "song" or "insectivorous" birds and obviates the necessity for special acts protecting species that do not properly come within either of these groups. Florida and

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[1] Collins, Fifteenth Ann. Rept. Ohio Board Agr. for 1860, p. 387, 1861.

[2] Geer *v.* State of Connecticut, 161 U. S. 519.

[3] Forest and Stream, XLII, p. 89.

Texas have special acts prohibiting the killing of "birds of plume," such as herons, egrets, and ibises; Maine, one prohibiting the killing of terns; Maryland, Michigan, Oregon, Utah, and Virginia protect gulls; several States, notably Alabama, Illinois, Pennsylvania, and Utah, have begun to protect birds of prey, and a majority of States now protect "insectivorous" birds. The uniform adoption of the proposed act would greatly simplify legislation.

PROSPECT FOR ENFORCEMENT OF GAME LAWS.

With the present widespread interest in birds, there is every reason to hope that in future laws will not be allowed to become dead letters. Fish and game commissions, sportsmen's associations, Audubon societies, farmers, and the general public are all interested in the cause of bird protection.[1] In January, 1898, the League of American Sportsmen was organized for the special purpose of enforcing game laws and protecting song and insectivorous birds. This association, which is composed of representative sportsmen in all parts of the United States, advocates the propagation of game and the enactment of laws licensing guns, limiting the killing of game, and prohibiting the sale of game at all seasons.[2]

INTRODUCTION OF FOREIGN BIRDS.

Much interest has been manifested in importing song birds and game birds from other lands to supplement the list of native species or replace those which are rapidly decreasing. Neither expense nor failure prevents the frequent repetition of such experiments, although scarcely half a dozen of the thirty or forty introduced species have really become acclimated in the United States. Besides the English sparrow and the European tree sparrow, a score or more kinds of song birds and ten or twelve of game birds have been imported at various times.

The introduction of the English sparrow (*Passer domesticus*) is one of the most familiar examples of acclimatization. Brought over to the United States in 1850, the bird developed such a marvelous ability to adapt itself to new surroundings and increased so rapidly that by 1870 it had gained a foothold in twenty States and the District of Columbia, as well as in two provinces of Canada. At the present time it is found in every State and Territory except Alaska, Arizona, Montana, Nevada, and New Mexico. It is known everywhere as a great pest, and Illinois, Michigan, Ohio, and Utah are now offering bounties for its destruction.[3] The closely related European tree

[1] For list of State officials and associations concerned with the protection of birds and game, see Appendix.

[2] Recreation, VIII, p. 233, 1898.

[3] A full account of the habits and distribution of the English sparrow may be found in Bulletin No. 1, Division of Ornithology and Mammalogy, 1889; see also the Yearbook of the Department of Agriculture for 1898, pp. 98–101.

sparrow (*Passer montanus*) has been introduced at St. Louis, Mo., but has never spread to any extent. Twenty birds were imported in 1870, and the species is well established in the country immediately about the city. It is much less objectionable than the English sparrow, and is said to lack the fighting qualities which have made the latter bird so unpopular.

Importation of song birds from Europe began about the middle of the century. Thomas Woodcock, president of the Natural History Society of Brooklyn, is said to have brought over a number in 1846, and the following season goldfinches, linnets, bullfinches, and skylarks were seen at Greenwood and in the suburbs of Brooklyn. The last species survived two winters.[1] Early in 1853 John Gorgas liberated 42 skylarks at Wilmington, Del., and a number were set free at Washington, D. C.[2] Allen states that in 1853 a considerable number of skylarks, wood larks, English blackbirds and other thrushes, robin redbreasts, and goldfinches were set at liberty in Greenwood Cemetery, New York.[3]

Between 1872 and 1874 the Acclimatization Society of Cincinnati, Ohio, spent about $9,000 in importing some 4,000 European birds, belonging to about 20 species, but the experiment resulted in failure. At nearly the same time the Society for the Acclimatization of Foreign Birds liberated at Cambridge, Mass., a considerable number of European goldfinches (*Carduelis carduelis*) and other species. About 1877 a number of starlings (*Sturnus vulgaris*) were set free in Central Park, New York, by the American Acclimatization Society. This was followed by several similar experiments, only the last of which, in 1890, when 60 birds were released, seems to have been successful. Goldfinches set at liberty at Hoboken, N. J., in 1878, appeared in Central Park, New York, in the following year, and were found breeding in 1886.[4] In 1889 and 1892 the Society for the Introduction of European Song Birds, of Portland, Oregon, imported two lots of birds at a cost of about $2,000. Some 20 species were represented, including 50 pairs of skylarks, 30 pairs of black thrushes, 35 pairs of starlings, and 15 pairs of green linnets. As a result of these numerous importations, the European tree sparrow has become established in the vicinity of St. Louis, Mo.; the European goldfinch has been found at various times in several places in eastern Massachusetts and in Central Park, New York; the skylark has become acclimated on Long Island, N. Y., and in the vicinity of Portland, Oregon; the starling is slowly spreading up the lower Hudson Valley and has also gained a foothold at Portland; a few other species are reported to be doing well in Oregon, but all the rest have failed to survive.

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[1] Forest and Stream, XI, p. 406, 1878.

[2] Rept. Comm. Patents for 1853 (Agr.), pp. 70–71.

[3] Bull. Nuttall Orn. Club, V, p. 120, 1880.

[4] Adney, Auk, III, pp. 409–410, 1886.

The introduction of game birds has been far more successful than that of song birds. The species include the English pheasant (*Phasianus colchicus*), the ringneck or Mongolian pheasant (*P. torquatus*), the green pheasant (*P. versicolor*), the golden pheasant (*Chrysolophus pictus*), the silver pheasant (*Euplocomus nycthemerus*), the capercailzie (*Tetrao urogallus*), the black grouse or black game (*Lyrurus tetrix*), the migratory quail (*Coturnix coturnix*), the partridge (*Perdix cinerea*), the Indian black partridge, and the sand grouse. Of these, the most important are the English and Mongolian pheasants.

The Mongolian and other Asiatic pheasants were sent to Oregon from China by Judge O. N. Denny, formerly consul-general at Shanghai, and the first importation was apparently made in 1881. Most of the birds died on the way and only 15 (12 males and 3 females) reached Portland alive. These were liberated at the mouth of the Willamette River, about 12 miles below the city. The second lot, received in 1882 (?), comprised 35 or 36 ringnecks, which were set at liberty 12 miles east of Albany, in the Willamette Valley. Nineteen ringnecks were also liberated in 1882 at Victoria.[1] Golden and silver pheasants were imported two or three years later and, with some ringnecks, were placed on Protection Island, near Port Townsend, Wash.[2] These four colonies all flourished, and from them birds were carried to other parts of the Pacific coast. The Mongolian did far better than the others, and increased so rapidly that in 1891, when complete protection was removed, they had spread over a considerable part of western Oregon. English pheasants have been imported mainly in the Eastern States; some were liberated near Tarrytown, N. Y., about thirty-five years ago; 78 were turned out on Jekyl Island, near Brunswick, Ga., in 1887, and these increased to 850 during the following year;[3] others were introduced into New Jersey. Since 1890 there has been widespread interest in these experiments, and pheasants (mainly Mongolian) have now been introduced into at least twenty-five States and have increased rapidly through protection laws and the establishment of pheasantries for their propagation. Of the other species, little need be said. About 1881, 3 sand grouse were liberated near Portland, Oregon, and 9 farther west on the Clatsop Plains, but all promptly disappeared. An importation of Indian black partridges was made in 1891, but only 3 lived to reach their destination, at Macomb, Ill.[4] The black grouse has been liberated in Newfoundland and in Vermont and elsewhere in the Eastern United States. Recently the capercailzie has been introduced in the Adirondacks. European quail have been introduced several times,

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[1] Forest and Stream, XXXV, p. 28, 1890.

[2] Ann. Rept. Dept. Agr. for 1888. pp. 484-488.

[3] Forest and Stream, XXXI, p. 221, 1888.

[4] Ibid., XXXVII, p. 123, 1891.

and in 1879 nearly 3,000 were distributed in various places in New England and the Middle States,[1] but all disappeared after a year or two.

In Hawaii foreign birds have been introduced from both Asia and America. They include the Indian mina (*Acridotheres tristis*), the Java sparrow (*Munia oryzivora*), old world pheasants, the eastern turtle dove (*Turtur chinensis*) and two species of herons from China, the house finch (*Carpodacus mexicanus frontalis*) and California quail (*Lophortyx californicus*) from California, the rice bird, and the English sparrow.[2] Of these, the mina and the English sparrow are the most abundant, and display the same well-known traits which have given them an unenviable reputation elsewhere. The native birds comprise about a hundred species, and among those peculiar to the islands are some of very great interest, but which, unfortunately, are rare. Since the advent of the mongoose and of the introduced birds, some of the native species have been still further reduced in numbers, and apparently are in danger of extermination in the near future.

In the eagerness to acquire new birds, the risk of importing undesirable species has been overlooked, and even the lesson of the English sparrow has not been enough to impress on the general public the dangers of ill-advised acclimatization. But the acquisition of Hawaii and Puerto Rico, both suffering from the introduction of the mongoose, has given new importance to the subject of acclimatization, and has shown the necessity, not only of preventing the pests already on these islands from being brought into the United States, but also of protecting our new possessions against future experiments in the introduction of dangerous species. If we are to escape the losses which have been suffered in the Australian colonies, and especially in New Zealand, some restriction must be placed on the introduction of exotic species, as is now done in Western Australia. Attention has been called to this question, and it is to be hoped that the suggestion that such experiments be placed under the control of the Department of Agriculture will receive the approval of Congress at an early date.[3]

SUMMARY.

The history of American ornithology may be traced back to the middle of the sixteenth century, but the chief progress in the science has been made during the last hundred years. So assiduously have our birds been studied that the avifauna of few regions is better known than that of the Eastern United States. With the growth of ornithology, the economic relations of birds, and especially their relations to agriculture, have attracted more and more attention. During the last half century "economic ornithology" has become

[1] Forest and Stream, XII, p. 371, 1879.

[2] Ray, Osprey, IV, p. 1, September, 1899.

[3] Ann. Rept. Dept. Agr. for 1886, p. 258; Yearbook Dept. Agr. for 1898, p. 108.

recognized as a special branch of the science and has undergone rapid development. The relation of birds to agriculture depends mainly on the character of their food, and this is determined in several ways: (1) By field observation; (2) by experiments on birds recently captured, and, (3) by examination of stomach contents in the laboratory—the latter the most complete and satisfactory method. Thus far, about 20,000 birds' stomachs have been examined, and data are now available for determining the extent to which a hundred or more important species are useful or injurious. The English sparrow and several hawks and owls have been condemned, but only six or eight species in all have thus far been found injurious, while several birds commonly considered injurious have been shown to be beneficial.

The harvesting and commercial utilization of bird products has been marked by great waste and a reckless disregard for the future. The game markets, the egg trade, and the millinery trade have all made heavy drafts on our native birds, and have decimated some useful or conspicuous species and forced others to the verge of extinction. This is particularly noticeable in the case of the passenger pigeon, the egrets of the South, and the terns of the Atlantic coast. Attempts are now being made to place the killing and sale of game under proper restrictions; the trade in sea birds' eggs has been curtailed, and wide publicity has been given to the enormous slaughter of birds exacted by the demands of fashion. The guano trade, which resulted in the acquisition of a number of islands whose product was valued at more than $3,000,000, is now largely a thing of the past, owing chiefly to the depletion of the deposits, although the fact that better artificial fertilizers can now be had at lower rates than natural guano is also partly responsible for this result.

Legislative measures early in the century took the form of bounty acts directed toward the destruction of birds, but most of these have now been withdrawn, except in the case of the English sparrow. Protective measures, commonly known as "game laws," have multiplied, and protection is now extended not only to game birds but also to insectivorous species and in some States to birds of prey. That these efforts have not accomplished more, is mainly because the laws have lacked uniformity and have not been properly enforced, but the last decade has certainly witnessed some progress along these lines. Efforts have also been made to supplement State laws by federal legislation restricting interstate traffic in game killed in violation of State regulations, but although several bills embodying this principle have been considered by Congress none have as yet become laws.

Experiments in the introduction of foreign species have not met with unqualified success. English and Mongolian pheasants have been added to the list of game birds, and the European skylark, starling, and tree sparrow have gained a slight foothold in a few localities, but we have also acquired the English sparrow, one of the worst of feathered pests.

With the present knowledge of the economic relations of birds based on thorough scientific investigation, and with the recent experience of the effects of indiscriminate slaughter and unrestricted acclimatization, there is every reason to hope that practical questions in economic ornithology will hereafter receive more careful and intelligent consideration.

PROGRESS OF FORESTRY IN THE UNITED STATES.

By Gifford Pinchot,
Forester.

ATTITUDE OF THE PIONEERS TOWARD THE FOREST.

The sentiment for forest protection was strong among the early settlers of the United States. In Massachusetts repeated enactments provided for the care and protection of the forests adjacent to the various communities. In New Jersey laws against forest fires took their places very early upon the statute books. In Pennsylvania the founder of the Commonwealth made it a condition that, of all land acquired from him, 1 acre of forest should be left standing for every 5 acres cleared. This conspicuous care for the forest in regions where at first it was a hindrance rather than a help to the gaining of a livelihood is explained by the early associations of the settlers. They came from a country where wood was comparatively scarce, and where the penalties for its destruction were severe and severely enforced. The respect for the forest which had been bred in their ancestors by the early English game laws, and continued in themselves by enactments of extreme rigor, was brought over almost without change to their new land, but it was not destined to last. A growing realization of the vast resources at their command, together with the bitter struggle of the farmer against the forest in the early days, gradually replaced care with carelessness, and respect with a desire for destruction. The feeling bred by the battle against the forest began to take a dominant place in the minds of the people and to prepare that mental attitude which is still responsible for the greater part of the forest destruction even yet in almost undiminished progress over by far the larger part of the United States.

EARLY PROTEST AND ACTION AGAINST FOREST DESTRUCTION.

Following the spread of forest destruction came protest and action against it. In the last decade of the eighteenth century the New York Society for the Promotion of Agriculture, Arts, and Manufactures, and in the first years of the nineteenth, the Massachusetts Society for the Promotion of Agriculture, took action, inspired by a desire to protect and promote the growth of forests. In 1799 Congress passed an act for the purchase of timber suitable for the use of the Navy, or of land on which such timber was growing. This law, reenacted in 1817 and supplemented in 1820, 1822, 1827, 1828, and 1831, led to the purchase and partial protection of 244,000 acres of forest-bearing land in Florida, Alabama, Mississippi, and Louisiana, and, in Florida, to some partially successful efforts at the culture of the live oak.

DEVELOPMENT OF A FOREST POLICY.

Immediately following the civil war came a development of railroad building without parallel in the history of the world, and with it a coincident extension of the lumber trade and of forest destruction. Agitation followed it feebly and at a distance, but not without planting the seed from which the present agencies for forest protection have sprung. In 1867 horticultural and agricultural societies in Wisconsin appointed a committee to report on the results of forest destruction, and two years later the Board of Agriculture of Maine took action toward the formulation of a forest policy for the State. Laws for the encouragement of tree planting were passed between 1868 and 1874 in nine Western and two Eastern States, and in 1873, 1874, 1876, and 1878 Congress passed and amended the timber-culture acts, which provided for the granting of homesteads to settlers who planted one-fourth of their entries with certain specified kinds of trees. The very mediocre results of these measures led to their repeal in 1891.

In 1831, under the act of that year, a partial oversight and protection of the public timber lands was assumed by the Solicitor of the Treasury, acting through the regular agents of the Department. This function was transferred in 1855 to the General Land Office, in the Department of the Interior, where it has since resided. Under this system cases of deliberate trespass were settled by payment of the stumpage value of the timber unlawfully taken, while cases of unintentional trespass were satisfied by actual entry, with the payment of customary entry fees. Express appropriation for the pay of special timber agents was not made until 1872, when $5,000 was appropriated, and this amount was continued annually thereafter until 1878. The ineffectual working of the system was recognized in that year by an appropriation of $25,000 to meet the expenses of suppressing depredations. Appropriations for this purpose were afterward increased to a maximum of $120,000 in 1893.

The same act which repealed the timber-culture laws contained a clause, whose insertion was due largely to the efforts of members of the American Forestry Association, by which the President was authorized to set aside "any part of the public lands wholly or in part covered with timber or undergrowth, whether of commercial value or not, as public reservations, and the President shall, by public proclamation, declare the establishment of such reservations and the limits thereof." Under the provisions of this clause, which may fairly be described as the first marked step toward a national system of forestry, the reservations shown in fig. 4 were set aside. The existence of some 18,000,000 acres of forest reserves, wholly without care or management by the Government, was perhaps the primary cause which led the Secretary of the Interior, in February, 1896, to address to the president of the National Academy of Sciences a request for an investigation and report upon the "inauguration of a rational forest policy for the forested lands of the United States," and upon the questions which underlie it. In reply, Dr. Wolcott Gibbs recited the difficulties of the undertaking and the best means of surmounting them, and expressed his willingness to comply with the Secretary's request.

The result of this correspondence was, on the part of the academy, the appointment of a committee of seven, of whom six were chosen from among its most distinguished and experienced members, the seventh being a professional forester, and on the part of the Government, the appropriation of $25,000 to defray the committee's traveling and other expenses. All its members served without pay. After a summer spent in active examination of forest reserves, proposed and established, on the ground, the committee recommended as a preliminary step the segregation of eleven new reserves with a total area of somewhat more than 21,000,000 acres. These reserves were established by the President on February 22, 1897. The wording of the proclamation led many persons to believe that the lands reserved were to be wholly withdrawn from every sort of use and development, a belief carefully fostered by some who, for reasons of their own, were opposed to the reserves. No pains were taken to enlighten the public upon this point until the harm had been done. The report of the committee, whose appearance would have done much to set matters straight, was not submitted until May 1 of the same year. Vigorous and even violent attacks upon the President and upon the committee and its members became frequent in Congress and culminated, after a spirited fight, in a provision of law which suspended the action of the proclamation of the new reserves, except in the State of California, until March 1 of the succeeding year (1898). In the meantime public sentiment concerning the reserves underwent a remarkable change. A better understanding of their objects and a knowledge of the new law (act of June 4, 1897), which regulated their use in practical accord with the principal recommendations of the committee, spread throughout the West. A further official study of the reserves, while it suggested certain modifications of their boundaries, served to confirm their desirability as a whole, and an attempt to continue the suspension beyond March 1 failed completely. Instead, the estimate of the Secretary of the Interior for their care and preservation was more than doubled by the appropriation of $175,000 in Congress for that purpose, and shortly after President McKinley proceeded to establish further

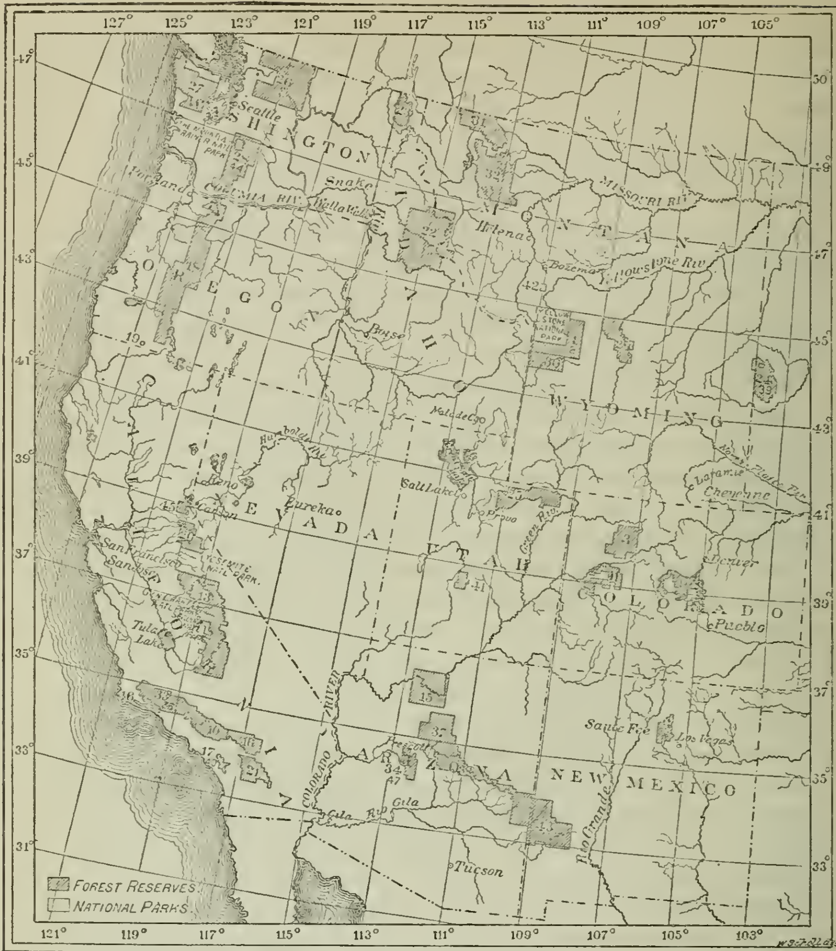

FIG. 4.—Forest reserves and national parks: 1 and 2, Yellowstone Park Timber Land Reserve, Wyoming, 1,239,040 acres; 3, White River Plateau Timber Land Reserve, Colorado, 1,198,080 acres; 4 and 35, Pecos River Forest Reserve, New Mexico, 431,040 acres; 5 and 6, Pikes Peak Timber Land Reserve, Colorado, 184,320 acres, 7, Bull Run Timber Land Reserve, Oregon, 142,080 acres; 8, Plum Creek Timber Land Reserve, Colorado, 179,200 acres; 9, South Platte Forest Reserve, Colorado, 683,520 acres; 10, San Gabriel Timber Land Reserve, California, 555,520 acres; 11, Battlement Mesa Forest Reserve, Colorado, 858,240 acres; 12, Afognak Forest and Fish-Culture Reserve, Alaska, 403,640 acres; 13, Sierra Forest Reserve, California, 4,096,000 acres; 15, Grand Canyon Forest Reserve, Arizona, 1,851,520 acres; 16, San Bernardino Forest Reserve, California, 737,280 acres; 17 and 40, Trabuco Canyon Forest Reserve, California, 109,920 acres; 18, Cascade Range Forest Reserve, Oregon, 4,492,800 acres; 19, Ashland Forest Reserve, Oregon, 18,560 acres; 20, Stanislaus Forest Reserve, California, 691,200 acres; 21, San Jacinto Forest Reserve, California, 737,280 acres; 22, Bitter Root Forest Reserve, Idaho and Montana, 4,147,200 acres; 23, Priest River Forest Reserve, Idaho and Washington, 645,120 acres; 24 and 39, Black Hills Forest Reserve, South Dakota, 1,211,680 acres; 25, Uintah Forest Reserve, Utah, 875,520 acres; 26, Washington Forest Reserve, Washington, 3,594,240 acres; 27, Olympic Forest Reserve, Washington, 2,188,800 acres; 14, 28, and 44, Mount Rainier Forest Reserve, Washington, 2,027,520 acres; 29, Big Horn Forest Reserve, Wyoming, 1,127,680 acres; 30, Teton Forest Reserve, Wyoming, 829,440 acres; 31, Flathead Forest Reserve, Montana, 1,382,400 acres; 32, Lewis and Clarke Forest Reserve, Montana, 2,926,080 acres; 33 and 36, Pine Mountain and Zaca Lake Forest Reserve, California, 1,644,594 acres; 34 and 47, Prescott Forest Reserve, Arizona, 423,680 acres; 37, San Francisco Mountains Forest Reserves, Arizona, 975,360 acres; 38, Black Mesa Forest Reserve, Arizona, 1,658,880 acres; 41, Fish Lake Forest Reserve, Utah, 67,840 acres; 42, Gallatin Forest Reserves, Montana, 40,320 acres; 43, Gila River Forest Reserve, New Mexico, 2,327,040 acres; 45, Lake Tahoe Forest Reserve, California, 136,335 acres; 46, Santa Ynez Forest Reserve, California, 145,000 acres. Total, 46,983,969 acres. The numbers on the map refer to proclamations creating or modifying reserves; hence, some of the reserves have more than one number.

FIG. 1.—TYPICAL FOREST IN STANISLAUS FOREST RESERVE, CALIFORNIA. PREVAILING SPECIES JEFFREY PINE, WITH A FEW WHITE FIR AND INCENSE CEDAR.

FIG. 2.—GENERAL FOREST VIEW IN STANISLAUS FOREST RESERVE, CALIFORNIA. OPEN FOREST OF YELLOW PINE, MIXED WITH WHITE FIR, SUGAR PINE, AND INCENSE CEDAR.

reserves. The area of all the reserves established by him up to January 1, 1900, is 6,708,425 acres.

The work of the committee of the National Academy of Sciences, while it failed of much that it might have accomplished, nevertheless was the spring from which the present activity in forest matters was derived. The proclamation of the reserves which it recommended drew the attention of the country as nothing else had ever done to the question of forestry. Vigorous discussion of forest matters by the public press led to a widespread interest, and that in turn to a keen appreciation of the value of forests in the economy of each State, and to a willingness to take measures to protect them. It may fairly be assumed that, as one of the results of this awakened interest, the policy of making Government forest reserves is now established beyond the reach of further question. (Pl. IX.)

ADMINISTRATION OF THE NATIONAL FOREST WORK.

One of the consequences of the controversy which ended in the retention of the reserves was the division of the responsibility for them between two bureaus of the Department of the Interior, and the consequent separation of the forest work of the Government into three unrelated parts. As the matter now stands, the General Land Office is charged with the administration and protection of the reserves, the United States Geological Survey maps and describes them, and the Division of Forestry of the Department of Agriculture, in which are all the trained foresters in the Government service, has no relation whatever to this most important branch of the Government's forest work, except as the officers of the Department of the Interior may incidentally apply for assistance or advice. The connection of the United States Geological Survey with the forest reserves is obviously a temporary one, which will cease when the work of mapping and description is at an end; but the complete separation between the administration of the reserves in the General Land Office and the force of trained foresters specially equipped for that purpose in the Division of Forestry constitutes what is perhaps the most serious defect in the present organization of the federal forest work.

The force employed for the care and protection of the forest reserves under the General Land Office consists of 9 superintendents, 39 supervisors, and a number of forest rangers, which in summer attains 350, but which varies with the seasons and the danger from fire. Protection against fire, the foremost enemy of forests in America, is the most pressing and important duty which devolves upon this force. The law of June 4, 1897, from which the Secretary of the Interior derives his powers concerning the reserves, confers upon him, and through him upon the Commissioner of the General Land Office, every necessary authority and power for their management by whatever methods he may deem best. Legally there is no obstacle to the introduction of the most practical and approved ways of handling forest lands.

NATIONAL PARKS.

While the national parks, speaking strictly, do not at present form a part of the forest system of the United States, still, since one of their prime objects is the protection of the forests within their boundaries, they fall naturally within the sphere of the present paper. They differ from forest reserves chiefly in the fact that no lumbering can be carried on within them, that the mining laws, except in the case of the Mount Rainier National Park, do not apply to them, that their game animals are fully protected, and that they are under the care of the troops of the Regular Army, assigned to that duty by the Secretary of War, but under the orders, for that purpose, of the Secretary of the Interior, and reporting to him.

The best known and the largest of the national parks is the Yellowstone, with an area of 2,142,720 acres, located in Wyoming, with small portions in Montana and Idaho. The others are the Yosemite National Park (967,680 acres), the Sequoia National Park (161,280 acres), and the General Grant National Park (2,560 acres), all in California, and the Mount Rainier National Park (207,360 acres) in Washington.

PRIVATE FORESTRY.

The development of practical forestry in the United States has proceeded until recently along three principal lines—private, State, and national. Contrary to the general rule in other countries, practical forestry here began first on private lands and wholly without relation to governmental action. Apart from the attempts of lumbermen in the Eastern spruce regions, many of which were successful, to cut their timber so as to get a second crop, the first instance of systematic forest management in the United States occurred on the land of Mr. George W. Vanderbilt at Biltmore, N. C., beginning in 1892. (Pl. X.) From that time, although the work at Biltmore still continued steadily and successfully, until the middle of 1898 the application of forestry to large private tracts made little progress. Since then, under the impetus of an offer of advice and assistance from the Division of Forestry, private owners have taken the matter under advisement in considerable numbers, and practical work has already been under way, at the present writing, on considerable areas for more than a year. On January 1, 1900, the total area for the management of which assistance had been asked of the Division of Forestry was more than 2,000,000 acres. Lumber companies and forest-owning associations as well as individuals are directing their attention with increasing seriousness and frequency toward practical forestry.

CONSERVATIVE LUMBERING. A LARGE OAK CUT AND WORKED UP INTO CORD WOOD WITHOUT INJURY TO THE SAPLINGS ABOUT IT. BILTMORE, N. C.

While private forestry has thus been making noteworthy and rapidly accelerating progress in the recent past, practical forestry on Government land during the same period has not advanced beyond the incipient stages of forest protection. Nor are any of the States more advanced.

STATE FORESTRY.

Practical forestry has not yet been introduced on any State forest land, and even New York, which owns about 1,250,000 acres in the Adirondack and the Catskill mountains, has not yet progressed beyond the stage of simple protection. To have reached this, however, is a long stride in advance. The constitution of New York forbids the cutting, destruction, or removal of any tree on the "forest preserve," as the lands definitely assigned to forest uses held by the State are collectively called, a provision which is quite as effectively opposed to practical forestry as it is to forest destruction, and which must be regarded as purely temporary in character. The forests of the State, as well as its salt-water and fresh-water fisheries and its game animals and birds, are under the care of a commission of fisheries, game, and forests appointed by the governor, having under it a superintendent and a corps of subordinates in the woods. The sincere interest of the people of New York in the forest preserve is indicated by the recent appropriation and expenditure of $1,800,000 to increase the area of the preserve by purchase.

In Pennsylvania the acquisition of wild lands by the State for forest uses has become an established policy, and bids fair to result in the control and management of an area not greatly inferior to the forest preserve of New York; and Pennsylvania has no legal bar to practical forestry. Michigan has recently taken steps in the same direction, and several other States have taken or seem about to take similar action. It may be said of the forested States in general that public sentiment is moving rapidly toward a satisfactory treatment of the question of State forest lands.

The following is a list of States which exercise control of forest matters, with the respective authorities through which such control is exercised in each:

CALIFORNIA.—University of California. A State board of forestry was created in 1885, but was abolished in 1892, its experimental groves passing under the present control.

COLORADO.—Fish and game commissioner. A commissioner of forests was created in 1885. This office lasted for six years. Appropriations never more than $2,000.

KANSAS.—State forest commissioner since 1887.

MAINE.—State auditor, ex-officio forest commissioner, since 1891. This officer, though greatly restricted by the smallness of his annual appropriation of $400, exerts important influence through his published reports and by his administrative work in carrying into effect the excellent fire law of the State.

MASSACHUSETTS.—The State board of agriculture, which acts also as a board of forestry.

MICHIGAN.—Permanent commission of three members, serving without pay, but receiving traveling and other official expenses, was created in 1899.

MINNESOTA.—State forestry board, created 1899, cooperating with town and county boards, and consisting of nine members.

NEW HAMPSHIRE.—Forest commission, established in 1893. This is the outcome of two preliminary commissions of investigation, the first of which was appointed in 1885 and lasted four years, and the second, appointed in 1889, lasted two years. It consists of the State governor, ex officio, and four other members.

NEW JERSEY.—State geologist. No independent forest officer.

NEW YORK.—Fisheries, game, and forest commission. There have been three commissions. The first was created in 1885, and was known as the "State forest commission." It was remodeled in 1893, the number of its members being increased from three to five. In 1895 the forest commission and the fish and game commission were consolidated under the present title.

NORTH CAROLINA.—State geological survey. No independent forest officer.

NORTH DAKOTA.—Superintendent of irrigation and forestry since 1891.

OHIO.—State forestry bureau was created in 1885.

PENNSYLVANIA.—Commissioner of forestry, appointed in 1893. On the creation of the State department of agriculture in 1895 a division of forestry was provided for, of which the forest commissioner became chief.

FOREST-FIRE LEGISLATION.

The legislation enacted by the various States with the object of preventing damage from forest fires is, on the whole, of a very satisfactory character. The main difficulty lies in the unwillingness or inability of the authorities in the various States to enforce the laws as they stand. Legislation is in most cases in advance of public opinion, but the latter is making very rapid progress. Among the best forest-fire laws are those of Maine, New Hampshire, Minnesota, New York, Pennsylvania, and Wisconsin.

The provisions of the New York law direct the appointment by the fisheries, game, and forest commission of a firewarden in each town in the counties comprising the forest preserve. Where special liability to injury from fire exists, the firewardens are required to divide their towns into two or more districts and to appoint one district firewarden for each. On the outbreak of a forest fire firewardens are directed to summon persons to assist in putting out or checking the fire, and no action which they may take to this end shall constitute a trespass. The firewardens and their assistants receive a fitting compensation for the time actually employed at the fire, the expenses being borne half by the town and half by the State. In towns not within the counties comprising the forest preserve supervisors of towns are made ex-officio firewardens. In addition to these safeguards the law makes it a misdemeanor to fire woods or waste lands belonging to the State or to another, whether willfully or negligently, if such fire results in

FIG. 1.—THE EFFECTS OF FIRE AFTER LUMBERING IN NORTHERN MINNESOTA.

FIG. 2.—FOREST LAND IN MINNESOTA DEVASTATED BY FIRE.

injury to woodland, and punishes the offender by a fine not exceeding $250 or imprisonment not exceeding one year, or both, besides awarding damages to the person injured.

The Minnesota law is very similar in general effect, but there is rather more central authority. The pay of the county wardens is not left to the counties, though not a dollar can be paid them without the approval of the county commissioners. The pay is limited to $2 per day, but can not exceed $15 a year. The chief firewarden, who has administrative control of all matters pertaining to the extinguishment of fires, secures the services of settlers to act as wardens in the unorganized territory. Minnesota has this advantage: That her forest-fire officials receive their pay more promptly than elsewhere, and thus take a more live interest in the performance of their duties. Pl. XI shows effects of fire in Minnesota.

THE DIVISION OF FORESTRY.

In 1873 a committee of the American Association for the Advancement of Science was appointed "to memorialize Congress and the several State legislatures upon the importance of promoting the cultivation of timber and the preservation of forests, and to recommend proper legislation for securing these objects." This action was followed by the appointment, in 1876, of Dr. Franklin B. Hough, of Lowville, N. Y., who may be considered historically, although not literally, as the first chief of the present Division of Forestry of the Department of Agriculture. Dr. Hough's duties were "to ascertain the annual amount of consumption, importation, and exportation of timber and other forest products, the probable supply for future wants, the means best adapted to the preservation and renewal of forests, the influence of forests on climate, and the measures that have been successfully applied in foreign countries or that may be deemed applicable in this country for the preservation and restoration or planting of forests, and to report upon the same to the Commissioner of Agriculture, to be by him in a separate report transmitted to Congress." In 1883 Dr. Hough was succeeded by Mr. N. H. Egleston, who in turn was followed, in 1886, by Mr. B. E. Fernow, who continued to direct the work of the Division until July 1, 1898.

At first and until recently purely a bureau of information, the Division of Forestry has become within the last eighteen months an active participant in practical forest work in the woods throughout the United States. Among the three federal organizations concerned with forest work (see page 297), the Division of Forestry is alone responsible for the progress of the science and art of forestry and for the vast interests which are involved in the spread of conservative forestry over the enormous private holdings of forest land in the United States. Its work has recently been reorganized throughout. This reorganization, together with the fact that the position and practice of the Division are largely typical of the present attitude of the Government toward forestry, makes requisite a somewhat extended description of its work.

The work of the Division is now chiefly in the field. Its office work is organized on a scale sufficient to support the field work and secure its best results, but the principal scene of its activities is in the woods. At present all the work of the Division is assigned to four sections, each with a man of special knowledge and qualifications at its head. These are the sections of working plans, of economic tree planting, of special investigations, and of office work. The following extract from the Annual Report of the Secretary of Agriculture for the year ending June 30, 1899, describes in sufficient detail the lines along which the work of the Division is now organized. The total appropriation for the year named was $28,520.

PRACTICAL ASSISTANCE TO FARMERS, LUMBERMEN, AND OTHERS.

Last October a circular was issued (No. 21 of the Division of Forestry) offering advice and practical assistance to farmers, lumbermen, and others in handling their forest lands, with a view to bringing about the substitution of conservative for destructive methods. This offer provided for the preparation of working plans, with full directions for work and with practical assistance on the ground, without cost to the owners of wood lots, but in the case of larger tracts requiring the owners to meet expenses for travel and subsistence, and for the necessary helpers for the agents of the Division while in the field.

During the year applications were received from 123 owners in 35 States for the management of 1,513,592 acres. Of these applications, 48 were for large tracts covering together 1,506,215 acres, the remainder being for wood lots.

Personal attention on the ground was given to 41 tracts, covering about 400,000 acres in 19 States. The contribution of private owners to the expenses of this work was about $3,000.

It was found possible for the owners of a majority of these tracts to carry out the working plans without personal assistance, but 15 of them required the active participation of the Division. On two of the latter, comprising 108,000 acres, the working plans were put into execution early in the year, and the first year's work has been successfully completed. The second year's work is being pursued under very favorable conditions.

As a result of a calculation, based on exact measurements, of the amount of lumber wasted by the prevailing practice of cutting high spruce stumps in the Adirondacks, there has been a decided change for the better on certain tracts, and at the same time a great reduction in the amount of young spruce cut for road building has been brought about. These are important changes.

In connection with the preparation of the working plans for the two large tracts in the Adirondacks, a special study has been made of the growth and production of the spruce on the eastern side of the mountains and of birch and maple on the western slope.

Of the total amount of land submitted for working plans, about 1,200,000 acres have not yet been examined. These tracts will be considered during the ensuing year as fast as the very inadequate force of the Division will permit, and working plans will be made for a selected number.

The Division has been thoroughly equipped with instruments for field work, in which it was wholly lacking at the beginning of the year.

COMMERCIAL TREES.

During the year five species of commercially valuable trees have been studied to determine their rate of growth and to ascertain their special qualities in forestry. The more important of these studies relate to the loblolly pine in North Carolina, a tree of the first economic importance, and the red fir in Washington, also called Douglas fir, yellow fir, Oregon pine, etc., one of the most valuable and widely distributed trees of the world. These studies have met with the cordial approval of lumbermen, and much practical assistance has been rendered by them. In addition, the study of the coast redwood in California has recently been begun, and later, if enough money can be saved for that purpose, the white oak and the hickories will be taken up.

ECONOMIC TREE PLANTING.

The planting of experimental plats in cooperation with State agricultural experiment stations has been discontinued, and the stations have taken over the plantations and assumed the responsibility for them. This was done after a thorough study of the old plan, after careful examination of the plantations at nine of the eleven stations, and with the acquiescence of the authorities of every station. Two other lines of work have taken the place of experimental tree planting. One is a careful study of the results of the planting already done, in which all the species used in the cooperative plantations are represented, and from which practically all the results to be expected from them after many years may be gathered without delay and far more cheaply; and the other the giving of practical assistance to tree planters under the terms of an offer (set forth in Circular No. 22, Division of Forestry) similar to that made to forest owners.

Close relations have been established with five of the most competent men in the treeless regions, and these gentlemen are preparing reports on subjects of direct interest to tree planters.

In addition to the studies now being pursued, the work of the present year will in great measure be devoted, first, to giving practical assistance to tree planters in the selection of the proper trees to plant and in planting them rightly, and, secondly, to an attempt to determine the true effect of bare and wooded or brush-covered slopes on the run-off of streams. The vast interests affected by the solution of this difficult problem will justify the most persistent and careful work.

SPECIAL INVESTIGATIONS.

Forest fires have been studied historically and in the field, and important results have been reached. Records of more than 5,000 fires have been compiled and classified, and field work has been prosecuted in seven States.

A series of studies of North American forests by experts with special knowledge of definite localities is in progress, and it is expected that three of them will be completed during the coming winter.

Historical studies of the progress in forestry in New Jersey, Massachusetts, and other States have been begun, and those for New York are practically completed.

Much material has been collected for a general account of the progress of forestry in the United States and of the practical application of conservative forest treatment in this country up to the present time.

Noteworthy progress has been made during the year in the photographic forest description of the United States.

OFFICE WORK.

The mailing list has been revised and extended, especially among newspapers, and much material for publication has accumulated and awaits attention during the winter. The botanical work formerly carried on by this Division has been turned over to the Division of Botany, where it more properly belongs.

During the year the force has been much increased, largely by the addition of young American foresters. At its highest, the total membership was more than five times that at the beginning of the last fiscal year.

Through a system of cooperation with experts in forest matters throughout the United States, the Division of Forestry is becoming in fact what it has long been in intention, the center of all forest activity in the United States, while through the appointment of student assistants it is gathering about its work a corps of young men, who, beginning their forest studies while actively engaged in the work of the Division, principally in the field, will complete them at one or another of the forest schools. In this way, as well as through the schools alone, the need for men, which is among the most pressing requirements of forestry in the United States at present, will gradually be met.

TREE PLANTING.

Tree planting in the treeless West is a legitimate and exceedingly important branch of forestry in the United States. The successful cultivation of farm crops in many portions of this country is dependent upon the protection derived from successful tree planting, and over a very large part of the agricultural West both the comfort of the farmer and his prosperity are deeply concerned with it. Tree planting has been in active progress for more than thirty years over considerable portions of the West, and a large amount of information has been collected as to the value for planting of a large number of trees. (Pl. XII.) This information has not been collated and is not available in any compact form. On account of the vastness of the interests involved, this is one of the most important pieces of forest work to be done.

ASSOCIATIONS.

The progress of associated effort for the protection of forests, slow at first, has of late years become very rapid. There are now some 22 associations in the United States which deal directly with forest matters. Of these the pioneer, if we disregard those which have not survived, and in many ways the most influential, is the American Forestry Association, founded at Cincinnati in 1882, under the name of the American Forestry Congress. This association, while less in number of members than the Pennsylvania Forestry Association, has done and is still doing work of the first importance toward the spread of right ideas about forestry, chiefly through its monthly organ, The Forester. The Pennsylvania association, founded in June, 1886, has been instrumental in placing the State for which it is named in the first rank of forest progress. It publishes a bimonthly journal entitled Forest Leaves. Among the other prominent organizations

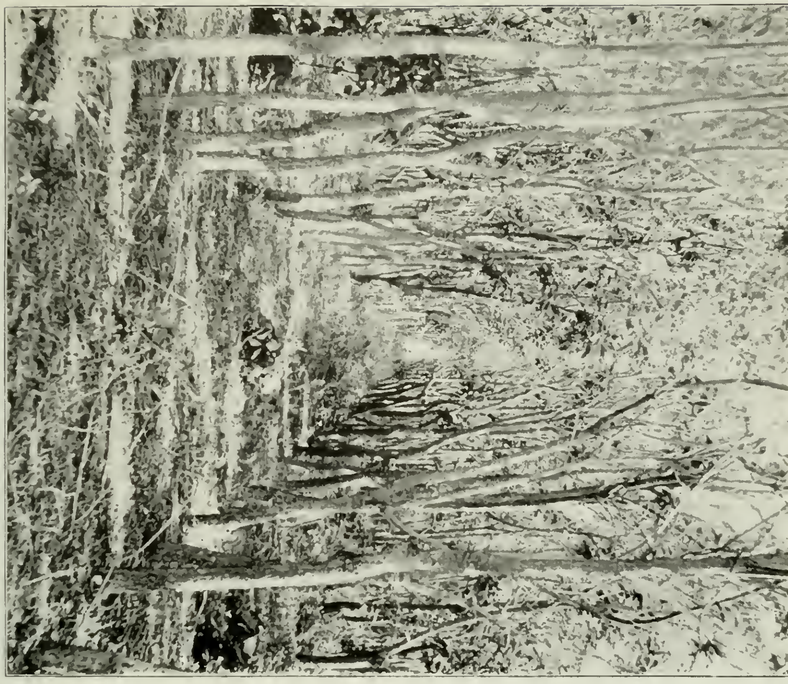

FIG. 1.—CATALPA PLANTATION, TWELVE YEARS OLD. RILEY COUNTY, KANS. A FEW YOUNG OAKS ARE GROWING BETWEEN THE ROWS OF CATALPA.

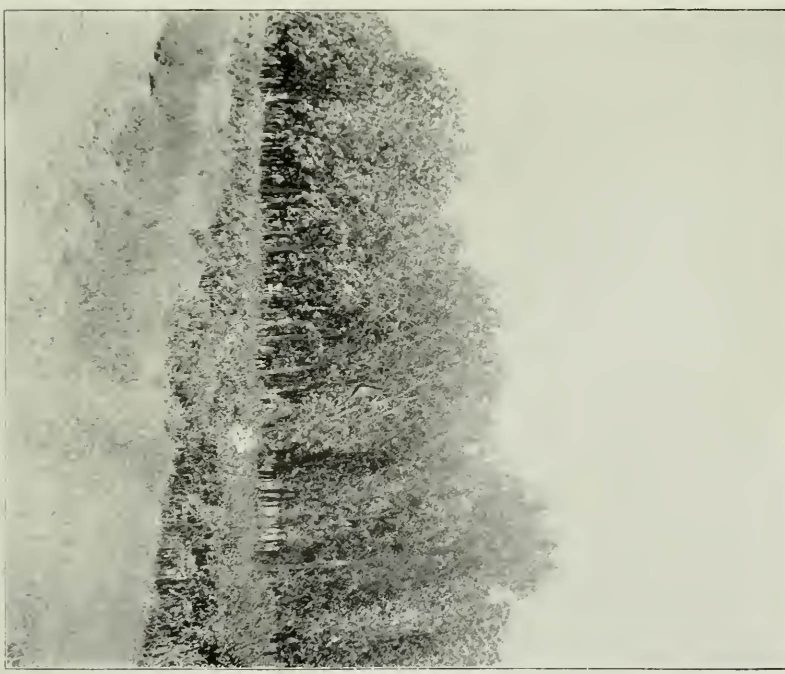

FIG. 2.—GROVE OF BLACK WALNUT, THIRTY-ONE YEARS OLD. RILEY COUNTY, KANS.

which have weight in forest matters are the Sierra Club and the Water and Forest Society of California, the Massachusetts, Wisconsin, Minnesota, and Colorado forest associations, and the Mazamas, of Oregon.[1]

INSTRUCTION IN FORESTRY.

Except in the case of the student assistants mentioned on page 304, the Government of the United States takes no part in the education of foresters. Elementary instruction in forestry has, however, already received noteworthy extension in the State agricultural colleges and to some degree in other institutions. Thirty-two of the former, according to the best information available, now offer instruction in forestry, either as a separate subject or in connection with courses in agriculture, horticulture, or botany. Among these institutions the college of agriculture of the University of Minnesota deserves special mention, both from the value of the forest courses it offers and because of its priority in the field.

The most elaborate and extensive institution in this country for the training of foresters is the New York State College of Forestry, organized in 1898 as a part of Cornell University. Modeled upon German lines, it offers a four years' course leading to a degree. Thirty thousand acres of forest in the Adirondack Mountains, controlled by the school, furnish an abundant field for practical operations. The Biltmore Forest School, also begun in 1898, is situated in Biltmore Forest, on the Vanderbilt estate, near Asheville, N. C., and offers a happy combination of practical and theoretical instruction. These, with Berea College, at Berea, Ky., which offers a year's work in forestry, and the University of Minnesota, are the principal agencies for the education of professional foresters.[1]

Steps have been taken which will result in the opening of a forest school as a department of Yale University in the autumn of 1900.

PROTECTION OF FISH AND GAME.

The protection of fish and game is less intimately associated with forest matters in the United States than in many other countries. Salt-water fisheries, which, because of the great length of coast line, produce so very large a portion of the total food product derived from the water, naturally have little connection with forests. As regards the fresh-water fishes and the game, separation between these two sets of interests and the forest has worked to the disadvantage of the latter. Hitherto it has been much easier to secure legislation for the protection of fish and game than for the protection of forests. In the future, however, as the various States produce or perfect their machinery for the right handling of forest lands, a much closer connection

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[1] A full list of States which have forest associations; also a list of the universities and colleges in which instruction in forestry is given, will be found in the Appendix to this Yearbook.—Ed.

may be expected, in which it is most probable that all the interests will find their profit. The protection of fish and game is a natural function of the forest guard.

ARBOR DAY.

Prominent among agencies for interesting the children in forest matters is the observance of Arbor Day. Instituted in Nebraska in 1872 by Hon. J. Sterling Morton, Secretary of Agriculture 1893–1897, Arbor Day has made its way from State to State until, at the beginning of 1900, provision for its observance has been made in every State and Territory. Its central idea is the planting of trees by school children on dates fixed by proclamations of the governors of the various States or by other authorities. The planting is usually accompanied by exercises, often of considerable elaboration, intended to impress upon the children the beauty and usefulness of trees, and to encourage the care and preservation alike of shade trees and forests. While the planting accomplished may have in itself little economic value, the institution of Arbor Day may fairly be said to exercise immense influence in exciting affection and respect for trees in the coming generations, and so to prepare a body of sentiment which will assist powerfully hereafter to bring about the general practice of conservative forestry.

PROGRESS OF AGRICULTURE IN THE UNITED STATES.

By George K. Holmes,
Assistant Statistician.

CRUDE BEGINNINGS BY INDIANS.

Indians carried on agriculture in a primitive and very limited way in the region now embraced in the United States before the country was inhabited by the white race, and to their crude agriculture they joined the harvesting of the wild products of nature.

SOME CROPS AND METHODS OF CULTIVATING AND GATHERING.

Indian corn.—The farming practiced on the eastern side of North America by the Indians was to burn off the forest, scrape up the top soil into little hills, and, if corn was to be raised, to plant the seed therein. Indian corn, or maize, was indigenous, and the Indians raised it from time immemorial. Women did the work, and the only implements employed were their fingers, a pointed stick for planting, and a clam shell or the scapula of an animal for a hoe. At the time of harvest the ears of corn were stored in a cache, or were hung up to dry, held together by the braided husks.

Tobacco.—Tobacco was another plant indigenous to America, and the Indians, who had learned its narcotic property, were in the habit of smoking the leaves after they had been dried.

Food and textile plants.—The Indians of northern California gathered the seeds of wild plants and roasted them on hot stones, to be ground afterwards into coarse flour by a stone operated in a hollow in a rock. Mojave Indian women planted gourd seeds in the crevices of rocks, and when the gourds were ripe gathered enormous quantities of them. Especially along the whole western coast of North America, Indian women gathered wild hemp, agave, and other textile plants; they dried the leaves or stalks, macerated them in water, extracted the fiber, and spun it on their naked bodies without the use of any implement whatever, and then made fabrics for domestic use.

Wild rice.—Throughout the Great Lake country the Indian women beat the heads of the wild rice plants while holding them over their canoes; having fanned the chaff away by using a large tray, they ground the rice in a mortar and cooked it in much the same way as corn.

WILD CHERRIES AND ROOTS.—The Sioux Indians beat dried wild cherries with buffalo meat to form their winter stock of pemmican. In Oregon and Washington an immense amount of food was gathered from the camass root, and also from the kouse root.

FRUITS, NUTS, ETC.—The Indians gathered the indigenous strawberries, huckleberries, blackberries, raspberries, cranberries, etc., and the chestnuts, butternuts, hickory nuts, walnuts, hazelnuts, and beechnuts. They lived also upon fish and the flesh of deer, bear, buffalo, and other wild animals, both fresh and dried.

BEGINNINGS OF AGRICULTURE BY THE WHITE RACE.

Next the white man came. Poor in the materials of wealth, indeed almost destitute of them, a stranger in a strange land with a strange climate, and beset by native enemies, the white settler had in prospect a simple subsistence upon a few products of a crude agriculture and an insignificant dairy, with such fabrics and other products as might be obtained from a primitive domestic industry. He saw the golden ears of maize strung up in the wigwams of the Indians and learned its value as food; he learned how to plant it, and also the value of putting fish for fertilizer under the seeds.

EARLY COLONIAL CONDITIONS.

Typical references to early colonial conditions are selected from Professor McMaster's "History of the people of the United States;" from Mr. Weeden's "Economic and social history of New England," and from Professor Bruce's "Economic history of Virginia in the seventeenth century."

In Georgia in 1790 the staple was tobacco, cultivated in the simplest manner, with the rudest of tools. Agriculture as we now know it can scarcely be considered to have existed. The plow was little used. The hoe was the implement of industry; made at the plantation smithy, the blade was ill formed and clumsy, and the handle was a sapling with the bark left on. After a succession of crops had exhausted the soil the cows were sometimes penned upon it.

In Virginia the poor whites, who had formerly been indentured servants, were the most lazy, the most idle, the most shiftless, and the most worthless of men. Their huts were scarcely better than negro cabins; the chimneys were of logs, the chinks being filled with clay. The walls had no plaster, the windows had no glass, and the furniture was such as they themselves made. Their grain was thrashed by driving horses over it in the open field; when they ground it, they used a rude pestle and mortar, or placed it in the hollow of one stone and beat it with another.

Each family in New England lived in a state of almost entire independence of other families and of all other communities than the one in which it lived. Beef or pork, generally salted, salt fish, dried apples, bread made of rye or indian meal, milk, and a very limited variety of vegetables constituted the food throughout the year. The Massachusetts farmer who witnessed the Revolution plowed his ground with a wooden plow, sowed his grain broadcast by hand, and when it was ripe cut it with the scythe and thrashed it on the barn floor with a flail. His house was not painted; his floor was not carpeted. When darkness came on his light was derived from a few candles of home manufacture. The place of furnaces and stoves was supplied by huge cavernous fireplaces which took up one side of the room and, sending half the smoke into the apartment, sent half the heat up the chimney. The farmer and his family wore homespun. If linen was wanted, the flax was sown and weeded, pulled and retted, and broken and swingled, for all of which processes nearly a year was required before the flax was ready for spinning, bleaching on the grass, and making and wearing. If woolens were wanted, sheep were sheared and the wool was dyed and spun and woven at home.

It was almost invariably true of all the settlers that the use and value of manures was little regarded. The barn was sometimes removed to get it out of the way of heaps of manure, because the owner would not go to the expense of removing these accumulations and putting them upon his fields.

In comparison with present conditions, the farmer's life in colonial days was a dreary one, filled with hardships and deprivations, and treading very closely upon the margin of subsistence. Those conditions continued after the Republic had been established, and were not measurably ameliorated until the present century had well advanced—until an improved intelligence, the dissemination of information, and especially the work of the inventor had begun to take effect.

FIRST CROPS.[1]

CEREALS.—The first yield of indian corn, or maize, in any considerable quantity produced in the United States by people of English blood of which we have any authentic record was that of 40 acres in the Jamestown Colony in 1609.[2] Wheat was first sown in Massachusetts on the southern coast as early as 1602, and it was first cultivated in Virginia in 1611. Rye dates back in New England certainly to 1648, and perhaps to 1630, and oats and barley to Gosnold's Colony in 1602.

BUCKWHEAT.—The first cultivation of buckwheat dates back to 1625 or 1626, on Manhattan Island.

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[1] Most of the statements under this head are taken from Eighty Years' Progress of the United States (1861).

[2] Bruce's Economic History of Virginia in the Seventeenth Century, Vol. I, p. 198.

POTATOES.—Plymouth Colony cultivated potatoes as early as 1629.

BEANS.—Beans have the date of 1602 on islands south of Massachusetts, the date of 1644 at Manhattan, and about the same date in Virginia.

FRUITS.—The first apples raised in this country were possibly from trees planted on Governors Island in the harbor of Boston, from which, on October 10, 1639, "ten fair pippins" were brought. Governor Endicott had on his farm in Salem, now Danvers, Mass., in 1640, the first nursery of young fruit trees that was ever planted in this country.

TOBACCO.—The English first saw tobacco cultivated and smoked in clay pipes by the Indians of Virginia in 1585, and the cultivation of tobacco was introduced into the Dutch Colony of New York as early as 1646, when it sold for 40 cents a pound.

FLAX AND HOPS.—Flax was taken to Holland from Manhattan Island as early as 1626. Hemp and flax were raised in Virginia prior to 1648. Hop roots were ordered by the governor of Massachusetts Bay as early as 1628.

SILK.—Silk culture was begun in Louisiana by the Company of the West in 1718. It was introduced into Georgia in 1732. Connecticut began the production of silk in 1760.

SUGAR CANE.—Sugar cane was first introduced into Louisiana in 1751, and the first plantation was established in 1758.

RICE.—The culture of rice was introduced into the colony of Carolina about 1694, the seed being obtained by the governor of the province from a ship from Madagascar.[1]

COTTON.—A pamphlet published in London in 1609 predicts that cotton would grow as well in Virginia as in Italy, and the author of another pamphlet, published in 1620, mentions cotton as a product that may be had in abundance in Virginia; but Bancroft's History of the United States says the first experiment in cotton culture in the Thirteen Colonies was made in Virginia in 1621, when the cotton seeds were planted as an experiment, and their "plentiful coming up" was at that early day a subject of interest in America and England. Cotton wool was listed in that year at 8 pence a pound, which indicates that it may have been grown earlier.[2]

FIRST DOMESTIC ANIMALS.

For many months after the arrival of the Pilgrims at Plymouth they had no beasts of burden; when at last a few cows were brought over they were poorly fed on the coarse wild grasses, and often they

[1] Pitkin's Statistical View of the Commerce of the United States of America (1816), p. 97.

[2] The Cotton Plant; published by the United States Department of Agriculture, pp. 30 and 31.

died from exposure and want of proper food or fell a prey to the wolves or the Indians. Owing to the difficulties and expense of importation, the price was so high as to put them beyond the reach of many even in moderate circumstances. In the colony of Massachusetts Bay a red calf soon came to be cheaper than a black one on account of the greater probability of its being mistaken for a deer and killed by wolves.

CATTLE.—When cows were so high as to sell, in 1636, at from £25 to £30 sterling at Plymouth and oxen at £40 a pair, a quart of new milk could be bought for a penny. The ox of that day was small, ill-shaped, and in every way inferior to the ox of the present time. During the early part of the last century the average gross weight of the neat cattle brought for sale to the Smithfield market was not over 370 pounds.

Dairy cattle were first brought to Virginia in 1611 and to Plymouth in 1624, from the coast of Devonshire. Some of the Virginia cattle were from the black cattle of Spain, and those brought to New York, possibly from the island of Texel on the coast of Holland, were mostly, without doubt, the black and white Dutch cattle. Those on the Delaware were brought from Sweden; those in New Hampshire were the large yellow Danish cattle, and, as the earlier importations were the most extensive that were made for many years, these various stocks were crossed and thus formed the original stock of the country.

The cattle along the northern Atlantic coast fared miserably in winter, having little or no protection from storms and cold and being poorly fed on hay made from overripe swale grass and salt grass cut from the marshes. It was a common opinion in the Virginia Colony that the housing and milking of cows in the winter would kill them.

HORSES.—The first horses taken from Europe to the Western Hemisphere were brought over by Columbus on his second voyage, in 1493. In 1527 forty-two horses were landed in Florida and perished soon after their arrival. The wild horses of the Southwest are probably descendants of the fine Spanish horses abandoned by De Soto on the failure of his expedition. In 1604 a French lawyer brought over horses to Acadia, and these probably laid the foundation of what are now known as Canadian ponies. In 1609 horses were brought to Jamestown, and in 1629 they were introduced into the colony of Massachusetts Bay. Horses were brought to New York in 1625 from Flanders. These importations seem to have been the original stock from which the race of American horses was constituted. But the horses of the United States, as in the case of other farm animals, have been much improved and diversified in special qualities during the last twenty-five years or so by the importation of thoroughbreds from Europe and by well-directed breeding.

SHEEP.—It is probable that the first sheep in this country came to Virginia in 1609 from England. About 1625 some sheep were brought to New York by the Dutch West India Company from Holland. Sheep were brought into the Plymouth Colony and that of Massachusetts Bay very soon after the settlement.

SWINE.—De Soto probably brought the first swine into this country in 1538 from Cuba, and these were landed in Florida. They were probably descended from some brought over by Columbus in 1493. The Portuguese brought swine into Nova Scotia and Newfoundland as early as 1653. The London Company imported swine into Virginia in 1609. They were introduced into the Plymouth Colony in 1624 by Governor Winslow, and into New Netherlands, now New York, in 1625 by the Dutch West India Company.

TRANSITION TO MORE RECENT CONDITIONS.

Although the early white settlers immensely improved and expanded the agriculture of the Indians, it is nevertheless true that in comparison with the agriculture of the present time that of the previous century and of the earlier half of the present century was crude, wasteful, uneconomical, expensive, laborious, and unscientific. The transition from the old to the new was gradual, but, having in mind long periods of time, it is apparent that American agriculture has had two distinct periods with regard to the characterization above specified. The change has been rapid since the civil war, and the last thirty years or so stand out conspicuously as belonging to a period of development and results, having little similarity to the long preceding period beginning with the eighteenth century and approaching an end about the middle of the present one.

In this paper only a brief mention will be made of some of the causes and opportunities of the agricultural expansion of the country.

EXPANSION OF POPULATION.

The principal opportunity for agricultural expansion was the immense cultivable area of virgin soil awaiting primarily to be despoiled of its fertility, which was subsequently to be partly restored and maintained by means of fertilizers.

The necessity for this expansion was a rapid and permanent growth of sturdy population, derived not merely from a natural increase, but largely from an unprecedented immigration from the peasant laboring classes of Europe—people who had been unable to obtain the ownership of land in a country of primogeniture, as well as people who had failed in other countries where land values were beyond their reach, and who came here with "a land hunger," where they found millions of fertile acres awaiting their acquisition at a cheap price.

The population of this country, according to the census of 1790, was 3,929,214; in 1850 it had increased to 23,191,876; in 1860, to 31,443,321; in 1880, to 50,155,783; in 1890, to 62,622,250; and various estimates of the population in 1900 place it at a figure somewhat above 75,000,000. Immigrants, who are included in these figures, numbered 143,439 in the ten years 1821–1830; from about 2,500,000 to 3,000,000 in each of the ten-year periods beginning with 1851 and ending with 1880, and 5,246,613 in the ten years 1881–1890. From 1891 to 1899, inclusive, the number was 3,396,011.

THE NONAGRICULTURAL POPULATION.

Since the birth of the nation there must be taken into account also the great and relative increase in the city population, which must derive its subsistence mainly from the agriculture of this country without contributing to agricultural production. The population living in cities and towns of 8,000 or more was 3.35 per cent of the total in 1790, 12.49 in 1850, 22.57 in 1880, 29.20 in 1890, and perhaps is about 35 per cent at the present time, or more than one-third of the entire population.

These percentages do not include the inhabitants of villages, towns, and the smaller cities not engaged in agriculture, who, if included, would swell the percentage above 35.

There has been a further marked increase in the nonagricultural elements of the population. In 1870 the persons 10 years of age and over who were engaged in manufacturing and mechanical industries were 19.61 per cent of the total number of persons of that age having gainful occupations, and this percentage had increased to 22.39 in 1890. It may easily be 25 per cent at the present time.

The number of persons employed in trade and transportation has increased from 9.83 per cent of the total number of persons employed in all occupations in 1870 to 14.63 per cent in 1890.

The percentage for persons engaged in professional services has increased from 2.97 in 1870 to 4.15 in 1890. For domestic and personal service the percentage has increased from 18.48 in 1870 to 19.18 in 1890.

The census group of occupations embraced within agriculture, fisheries, and mining is represented by 49.11 per cent in 1870, or nearly one-half of the persons having gainful occupations, and fell to 39.65 per cent, or about two-fifths, in 1890, and is likely to be hardly more than one-third at the time of the Twelfth Census (1900).

PUBLIC LAND.

While marked increase in the demand for agricultural products for consumption by persons who are in nonagricultural occupations has thus occurred, the Government at the same time has offered to agricultural producers a vast area of land at hardly more than a nominal price. Previous to July 1, 1897, final homestead entries to the number of 529,051 had been made for 70,396,856 acres belonging to the National Government; the number of entries in the following year was 22,281, covering 3,095,018 acres, and in the year previous to July 1, 1899, the number was 22,218, covering 3,134,149 acres—total to 1899, entries, 573,550; acres, 76,626,023.

During the twenty-two years preceding July 1, 1897, the public and Indian lands disposed of for cash and under the homestead laws, under the timber-culture laws, located with agricultural college and other kinds of scrip, located with military bounty land warrants, and selected by States and railroads embraced 299,961,357 acres; in 1898, 8,453,897 acres; in 1899, 9,182,413 acres—total for twenty-four years, 317,597,667. Some of the States and many railroad companies have been selling land, mostly for farms, amounting in the aggregate to a vast area. The number of sales on credit of tracts of land large enough to be measured by acres, from 1880 to 1889, inclusive, was 60,431 by States and 140,190 by railroads.

CAUSES OF INCREASED PRODUCTION.

While the country has been developing as above indicated, the great nonagricultural populations of European countries have been relatively increasing, and have exhausted in their consumption the farm production of their own countries, especially with respect to the items of wheat, corn, and other cereals, animal and dairy products, and, to the very small extent of cultivation, tobacco and cotton, thus opening up a foreign market, which has in a large degree warranted the expansion of the agriculture of the United States, along with the other causes or opportunities mentioned.

The decided decline in the cost of transportation has also contributed largely to the transformation under consideration.[1]

IMPLEMENTS AND MACHINES.

The most prominent feature in the development of American agriculture is the immense improvement that has taken place in agricultural methods and machines—indeed, the word improvement is not adequate to express the change that has taken place in the methods of agriculture in this country, because the implements and machines are creations rather than improvements, and their mission has been radical and far-reaching. They have reduced the amount of human labor required to produce a given quantity of crops and to cultivate given areas of land, and they have been largely, if not chiefly, instrumental in converting local markets into world markets for the principal cereals, cotton, tobacco, and animal and dairy products.

A technical description of these implements and machines can not be attempted here, and it will be sufficient merely to indicate generally changes in their character and in the results of their work.

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[1] The development of transportation facilities in the United States is the subject of another article in this Yearbook.—Ed.

Dependence must be placed upon the reader's knowledge of these machines and upon his mechanical mind to understand how and why they have contributed so much to the realization of the present agricultural era.

VEHICLES.—At the beginning of this century carts were used on the farms and chaises on the roads. Stagecoaches were used on the main roads of travel, and a few wagons were found here and there. Carts were more convenient for use with oxen on the farms. For many years discussion was active as to the comparative economy of oxen and horses for farm use, and wagons came in with the increased use of horses and the improvement of the country roads. Buggies and trotting horses grew up together. Light one-horse wagons first appeared in Connecticut about 1830, but it was not until 1840 or later that they became common enough not to attract notice when seen on the roads.[1]

PLOWS.—In 1637 there were but 37 plows in the colony of Massachusetts Bay. Twelve years after the landing of the Pilgrims the farmers around Boston had no plows, and were compelled to break up the ground and prepare for cultivation with their hands and with rude and clumsy hoes and mattocks. It was the custom in that part of the country, even to a much later period, for anyone owning a plow to do the plowing for the inhabitants over a considerable extent of territory. A town often paid a bounty to anyone who would buy and keep in repair a plow for the purpose of going about in this way.[2]

Mr. C. C. Coffin thus mentions the plow that his father used: "I think it was about 12 feet long. I know that it required eight to ten oxen to draw it, one man to ride upon the beam to keep it in the ground, and a man to follow behind with a heavy iron hoe to dig up the baulks."[3]

A writer in the Rhode Island American in 1820 describes the plow generally in use in the Eastern States at that time, known as the Old Colony plow, as follows: "It had a 10-foot beam and 4-foot land side; your furrows stand up like the ribs of a lean horse in the month of March. A lazy plowman may sit on the beam and count every bout of his day's work. Six of these plows cost me on an average, last year, $5 each to keep the shares and coulters fit for work, and the wear of the other parts could not be less than $1 more—$6 per year for each plow."

The first patent for a plow in this country was taken out by Charles Newbold, of New Jersey, in 1797. His was the first cast-iron plow

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[1] A Century of Connecticut Agriculture, by Prof. William H. Brewer, Twenty-eighth Annual Report of the Secretary of the Connecticut Board of Agriculture, 1894. p. 49.

[2] Eighty Years' Progress of the United States, p. 27.

[3] Arguments before the Committee on Patents of the Senate and House of Representatives, 1878. p. 272.

ever made, but the farmers in those times entertained great prejudices against it. There was a general idea throughout the country that a cast-iron plow would "poison" the land. Mr. Coffin remembers the first cast-iron plow used in his neighborhood in New Hampshire in 1837 and the assemblage of farmers who objected to it for the reason mentioned. He says that it required from 1797 to 1842 for the inventive genius of this country, together with the observations of farmers and mechanics, to arrive at any just conclusion as to what would be the best form for the plow.

Without mentioning intermediate plows, it will be sufficient to pass on to the Oliver chilled plow, which first appeared in 1870. This was a light, durable plow with a mold board of proper shape to economize draft and suitably turn the furrow, and this plow in a marked degree promoted the economy of plowing. It was stated by Mr. Coffin in 1878 that this invention, if used throughout the United States in the preceding year, would have effected a saving of $45,000,000 to the farmers of the country in the expense of plowing.

And then invention followed invention and improvement followed improvement, until we have sulky plows, gang plows, plows combined with harrow cultivators and with seed drills, side-hill plows, vineyard plows, beet plows, subsoil plows, double land-side plows, and lastly, what has been the aim, and seems to be the end, of plow invention, we have the steam gang plow combined with a seeder and a harrow, which has reduced the time required for human labor (in plowing, sowing, and harrowing) to produce a bushel of wheat, on an average, from 32.8 minutes in 1830 to 2.2 minutes at the present time, and which has reduced the time of animal labor per bushel from 57 to 1½ minutes; at the same time it has reduced the cost of human and animal labor in plowing, seeding, and harrowing per bushel of wheat, from 4 cents to 1 cent.

Corn planters.—Hundreds of patents have been issued for corn planters. The earlier ones were adjustments to the hoe, which permitted the release of grains of corn when the hoe was struck into the ground; then came the hand planter, and the next step was the horse drill. Next came the idea of marking rows in both directions with a drag. A long beam with pins in it was dragged both ways across the field by horses, and then the farmer would go along with the hand planter and plant the corn at the intersection of the rows. Still, again, followed an improvement, and this was the corn planter which planted two rows at one time with the rows running in both directions. A man sat on the machine, and, at every point where the drag had crossed at right angles, he moved a lever that dropped the corn, which was covered by wheels that turned and pressed down the soil upon the seed. The check rower followed; it was a simple implement, consisting of a wire chain or knotted rope stretching across the field and anchored at both ends. This passed through the machine as it was driven across the field and dropped some grains of corn every time the knot passed through a slot in the machine. It was only necessary to drive backward and forward all day long until the acres were planted, and then the corn could be cultivated in both directions. Subsequently, numerous check-row planters for corn have been invented with and without fertilizer adjustments, so that several rows of corn may be planted at the same time in places at regular distances apart, permitting cultivation in both directions.

CULTIVATORS.—Cultivators have been the subject of several thousands of patents. The original cultivation of corn and other crops planted in rows was by means of the hoe, but in the course of time a plow was used to loosen the earth and to suppress weeds and grass, being drawn twice between the rows and turning the soil against one or the other. Next a tooth harrow was employed, and this was drawn one way between the rows, and afterwards a cultivator with small double plowshares was used. Then followed the double-shovel cultivator, cutting deep or shallow, as desired, and turning the earth toward two opposite rows at the same time. The implement is now variously made, but it has reduced the economy of cultivation apparently to a minimum; the farmer may now ride while the cultivator is doing its work. He cultivates the rows of his crop in both directions, and the use of the hoe has been nearly, if not entirely, discontinued throughout large agricultural areas.

HARROWS.—Much attention also has been devoted to the invention of implements for harrowing and pulverizing the soil. The farmer no longer drives a brush harrow over his field as of yore, nor does he need to use a tooth harrow, but he has at his command disk harrows, screw pulverizers, smoothing harrows, spring-tooth harrows, and harrows combined with plows and seeders.

CORN HUSKER.—The mechanical corn husker is a machine of recent invention. Previously the husking of corn was done only by hand, and a peg strapped to the hand was often used for opening the husks; but there is now a machine that husks the corn and at the same time cuts the husks, stalks, and blades into feed, the motive power being steam.

CORN HARVESTER.—Again, we have the recent corn-harvesting machine drawn by horses that cuts the cornstalks and binds them into bundles at the same time.

CORNSHELLERS.—The steam cornsheller caused a remarkable change in the time and expense of the shelling of corn. In the olden time corn was shelled by hand, a frying-pan handle or shovel being used, the ears of corn being scraped against it, or perhaps the cob of one ear was used to shell the corn from another. Then came the first machine for shelling corn, a cylinder turned by a crank, by which a man might shell about 40 bushels in a day. Thousands of patents have been issued for cornshellers, and the culmination of them is the steam-power or horse-power cornsheller, which will shell a bushel a minute, carry off the cobs to a pile or into a wagon, and deliver the corn into sacks or wagons.

SEEDERS.—From the time when wheat was first sown, up to a comparatively recent period, the only method of sowing it was to throw it into the air by the hand. In this way it is impossible to sow evenly, especially if the wind blows with considerable force; and if clover seed is to be sown, the ground must be gone over a second time, while a third time is required if fertilizer is to be distributed. Then, when the harrow comes some of the grains are buried too deeply and some are not covered with earth enough. But not so many years ago inventors set to work to construct mechanical seeders, and the result is an almost complete abandonment of broadcast sowing by hand and the substitution of such seeders. They sow all kinds of grain and seeds at once, with fertilizer if required, and they harrow at the same time. They make the crop more certain. It is the general opinion that the wheat crop is increased one-eighth or more by the use of the mechanical seeders, especially in the case of winter wheat.

MOWERS AND REAPERS.—In 1794 a Scotchman invented what was described as a most marvelous and wonderful machine for cutting grain, doing as much in one day as seven men could do with the sickle. This marvelous machine was only the cradle. The reaper followed, and the first patent for one issued in this country was given to Hussey in 1833. McCormick took out his first patent in 1834, although he had constructed and tested a machine in Virginia in 1831 with some success; but the world heard little of reaping machines until 1845, when 150 of them were built at Cincinnati; by 1846 fully 300 had been built. There was a general trial of mowers and reapers at Geneva, N. Y., in 1852. Nine machines contested, for other inventors had taken out patents. Nineteen years had passed since the first patent had been issued. Out of the nine machines exhibited, not one could start in the grain without backing to get up speed. There was a heavy side draft, the machines were clumsy, and they could not turn easily.

By 1855 about 10,000 mowers and reapers had been built by different makers, nearly all being one-wheeled machines. There was an exhibition of reapers at the French exposition in 1855, in which there was one English, one French, and one American. The French machine did its allotted work in 72 minutes, the English in 66, and the American in 22.

Two years later, in 1857, there was a trial at Syracuse, N. Y., at which nineteen machines contested. Of these, all except three started in the grain without backing to get up speed. There was a trial at Auburn, N. Y., in 1866, at which forty-four different machines were entered, and of these, forty-two did their work in a satisfactory manner.

The mower and reaper combined cut the grain and left it on the ground bunched up in proper size for a sheaf, subsequently to be bound by hand. The harvester was supposed to be an improvement upon this, because it had a place for one or two men to ride to bind the grain as fast as it was cut; but the self-binder went beyond that and by means of a mechanical attachment did the binding without the aid of human labor. It was not until 1870 that the self-binder was a mechanical success; but that was not the end of invention for constructing machines to harvest wheat.

It remained for the ingenuity of man to construct a combined reaper and thrasher, with which it is necessary only to drive across the wheat field in order to obtain the grain ready for transportation to the elevator or elsewhere.

Cotton gin.—Without the cotton gin it would be practically impossible to raise and market the cotton crop of this country, which now commonly amounts to 10,000,000 bales and more annually. Before Whitney's invention it is said that the labor of one person was required for about ten hours to pick the seeds from 1½ pounds of cotton lint. At the present time one machine will gin from 1,500 to 7,500 pounds of lint in the same time, the quantity varying according to the size and power of the gin.

INFLUENCE OF PATENT LAWS ON DEVELOPMENT OF AGRICULTURAL MACHINES.

The development and creation of agricultural implements and machines by the inventive genius of this country is one of the most remarkable features of progress of the century. Its history is one of evolution and revolution—a revolution of incalculable consequences to human labor and the production and distribution of wealth, with an immense bearing upon the trend and character of industry, social life, and civilization.

This development has been encouraged by the patent laws of the country, and perhaps nothing could be more tersely expressive of the influence of these laws in promoting mechanical agriculture than a mention of the number of patents that have been granted. Under date of November 17, 1899, the Patent Office reports that patents for agricultural machines had been granted to the number indicated in each of the following classes: Vegetable cutters and crushers, 701; fertilizers, 822; bee culture, 1,038; trees, plants, and flowers, 1,102; care of live stock, 3,749; dairy, 4,632; thrashers, 5,319; harrows and diggers, 5,801; fences, 8,404; seeders and planters, 9,156; harvesters, 12,519; plows, 12,652.

It is no longer necessary for the farmer to cut his wheat with sickle or cradle, nor to rake it and bind it by hand; to cut his cornstalks with a knife and shock the stalks by hand; to thrash his grain with a flail, nor to drive horses over it to tread it out, nor to scrape the ears of corn against a shovel or the handle of a frying pan. It is no longer necessary for him to dig potatoes, nor to cut his grass with a scythe and to spread it with a pitchfork that it may dry, nor to pitch the hay from the wagon to the haymow in the barn, nor to pick the lint from cotton seed by hand, and so on with numerous operations throughout the whole range of agricultural work.

Mechanical contrivances have largely supplanted human labor in many respects, or have improved the application of labor and increased the product of agriculture, reduced the cost of production, augmented the farmer's gross income, and made his life an easier one than it was before the machine period.

This country has come to be without a peer in the manufacture of agricultural implements and machines, both in quality and number. The manufacturing establishments for producing them in 1890 numbered 910, with a capital of $145,313,997 and 42,544 employees, receiving wages to the amount of $21,811,761, turning out a product valued at $81,271,651. One of these establishments (the largest in the world), making various kinds of mowers and reapers, corn harvesters, corn huskers and shredders, and hayrakes, turned out 187,760 machines in 1898, or, on an average, one in less than a minute for every working day.

AGENCIES FOR AGRICULTURAL EXPERIMENT AND INFORMATION.

Along with the application of invention, have grown up numerous agencies for educating and training the farmer in agriculture, for disseminating information with regard to improvements, and for stimulating among farmers the associative spirit and increasing the benefits to be derived from cooperation.

The first of these agencies, chronologically, consisted of voluntary organizations for the promotion of agricultural interests. These, under various titles, existed in the colonies even before the beginning of this century. We have records of five established during the decade of 1785–1794, in the following States and in the order named: Pennsylvania, South Carolina, New York, Massachusetts, and Connecticut. This method of aid to agriculture has constantly increased during the nineteenth century, and agricultural societies, the name generally applied to them, have multiplied so that at the present day there are probably few counties in the United States where some form of agricultural society does not exist, while all the leading agricultural industries are represented by State, and, in many cases, by national organization.

Many of these voluntary associations receive State aid, and especially is this true of those organized mainly for the purpose of holding annual fairs. About 1,500 such associations are now in existence, extensively distributed throughout the country, but more especially throughout the North Central and North Atlantic States. Of farmers' clubs, it is sufficient to say their name is legion. Another of these agencies consists of the commissioners of agriculture or boards of agriculture of the different States, and almost every State has some official organization in the interests of agriculture. To these must be added the agricultural colleges and the experiment stations, in which the Federal and State governments cooperate.[1]

Finally, the most important of the agencies referred to is the Department of Agriculture itself, which began as an insignificant division in the Patent Office, Department of the Interior, in 1839, became a Department under a Commissioner in 1862, and in February, 1889, was erected into an Executive Department under a Secretary, who is a member of the Cabinet.

STATISTICS.

AGRICULTURAL CENSUSES.

Important and extensive collections of statistical information with regard to farms and their products have been made by national and State censuses.

The first statistics of agriculture collected by a United States census were obtained in 1840, within limits much narrower than those adopted in the censuses of 1890 and 1900.

At the present time it is the policy of the Census Office to procure an inventory of farm property and products, with detailed statements for acreage, values, quantities, and numbers of live stock, as far as applicable. It is expected that the national census of this year will procure many facts with regard to the farms of this country, which are now supposed to number about 5,000,000. No other country takes such a thorough, extensive, and detailed census of agriculture as does the United States.

The use of the censuses of agriculture might be the subject of extended discussion, but comparatively little can be said here. Not a day passes that the Department of Agriculture does not need to use census statistics of agriculture in many ways and for many purposes, not only in its own routine work of crop estimates and in the preparation and conduct of statistical investigations, but also in response to numerous letters received from residents of the United States and foreign countries.

Some of the States are required by their constitutions, or by legislative enactments, to take censuses, but not all of them comply with the requirement. The most elaborate State census of agriculture is taken by Massachusetts. Among the other States required to take

[1] No attempt is made here to explain even briefly the work of the agricultural colleges and experiment stations as a factor in the development of agriculture, both agricultural education, during th s century, and the work of the agricultural experiment stations being treated at length in other papers in this Yearbook.—Ed.

censuses are Indiana, Iowa, Kansas, Michigan, Oregon, Oklahoma, and Wisconsin.

Useful agricultural statistics are collected and published also by the boards of agriculture of the several States, notably by the States of Texas and Kansas.

BOARDS OF TRADE AND COTTON EXCHANGES.

At least twenty-five boards of trade publish statistics of the movement, distribution, prices, etc., of agricultural products, and the following is substantially a complete list of the cities in which these boards of trade are situated, the variants of the name being sometimes merchants' exchange, chamber of commerce, produce exchange, or commercial exchange: Baltimore, Md.; Boston, Mass.; Buffalo, N. Y.; Chicago, Ill.; Cincinnati, Ohio; Denver, Colo.; Detroit, Mich.; Duluth, Minn.; Indianapolis, Ind.; Louisville, Ky.; Memphis, Tenn.; Milwaukee, Wis.; New York, N. Y.; Omaha, Nebr.; Peoria, Ill.; Philadelphia, Pa. (commercial exchange and also produce exchange); Portland, Oreg.; Richmond, Va.; St. Louis, Mo.; San Francisco, Cal. (chamber of commerce and also produce exchange); Seattle, Wash.; Toledo, Ohio, and Washington, D. C.

Besides the foregoing boards of trade, there are many in the United States whose object is to stimulate concerted action by manufacturers, merchants, financiers, and persons especially concerned in carrying on the distributive processes. About 800 of these boards of trade have a national association, which speaks powerfully for interests representing many hundreds of millions of dollars of capital, and which substantially represents the class of persons known as middlemen, who distribute the products of the farm. But this national association does not include all of the boards of trade, chambers of commerce, and produce exchanges. These in the aggregate number between 1,300 and 1,400, the largest number among the States being found in New York; second to which stands Pennsylvania; third, Ohio; and, fourth, Massachusetts.

There is a class of these boards of trade especially concerned with cotton, generally known as cotton exchanges, which are associations of middlemen with the object of obtaining information in regard to the condition of the market as influenced by demand, supply, production, available cotton, and, in some cases, of dealing in futures. The cities and towns where these exchanges are situated are as follows: Eufaula, Birmingham, Mobile, Montgomery, and Selma, Ala.; Little Rock and Texarkana, Ark.; Atlanta, Columbus, Rome, Savannah, and Augusta, Ga.; Monroe, New Orleans, and Shreveport, La.; Greenville, Greenwood, Meridian, Natchez, Vicksburg, and Yazoo City, Miss.; St. Louis, Mo.; New York, N. Y.; Newbern, Wilmington, and Raleigh, N. C.; Charleston and Columbia, S. C.; Memphis and Nashville, Tenn.; Galveston, Dallas, Fort Worth, Sherman, Waco, and Houston, Tex.; Norfolk and Portsmouth, and Richmond, Va.

STATISTICS OF DEVELOPMENT.

The progress of American agriculture up to the present time has by no means been thoroughly discussed in this paper, nor is it possible to do so within the limits of a Yearbook article; hence only a few more topics can be mentioned. First, statistics expressing development will be given.

FARMS AND ACREAGE.—The number of farms increased from 1,449,073 in 1850 to 4,564,641 in 1890. During the same time the total farm acreage increased from 293,560,614 to 623,218,619 acres, of which the increase in improved acreage was greater, both absolutely and relatively, than the increase in the unimproved acreage.

INCREASING IMPORTANCE OF MEDIUM-SIZED FARMS.—The average size of farms declined from 203 acres in 1850 to 137 acres in 1890, and it has been established by a thorough statistical analysis that in the more recent years the increase in number of farms has more largely accrued to farms of medium size than to farms of the smaller and larger sizes. Why this should be so is only a matter of conjecture. It may be that the persons who acquire the proprietorship of farms, either as owners or as tenants, have become more able to acquire the possession of medium-sized farms, and so reject or consolidate the smaller farms; it may be also that the larger farms have not been found to be as profitable as medium-sized farms.

The use of machines is an important element in this country's agriculture, and possibly the medium-sized farm as it exists to-day is susceptible of being more economically cultivated and managed than either smaller or larger farms, and among the economic reasons for this the farm machine must be reckoned as highly important. But whatever the explanation may be, the fact remains that the middle-class farmer, according to the tendency disclosed by the census of 1890, is coming more and more to the front among agriculturists.

FARM REAL ESTATE AND MACHINES.—The value of the real estate of farms increased from $3,271,575,426 in 1850 to $13,279,252,649 in 1890. During this period the value of farm implements and machines increased from $151,587,638 to $494,247,467; but these numbers do not adequately represent the increase in the importance of implements and machines, partly because these figures take no account of the vast increase in their efficiency, which has been infinitely greater than the figures express, and in a very large degree because of the much cheaper prices prevailing in 1890.

FARM PRODUCTS.—The censuses have very poorly ascertained the value of farm products, the statements undoubtedly being considerably under the facts. The published statement of the census of 1890 gives the value of farm products as $2,460,107,454, but an estimate made on the production ascertained in the census of 1890 by Mr. J. R. Dodge, former Statistician of the Department of Agriculture, places the value of farm products in the agricultural year covered by that census at about $3,500,000,000.

FARM ANIMALS have increased as follows, as shown by national censuses: Horses, from 4,336,719 in 1850 to 14,969,467 in 1890; mules and asses, from 559,331 in 1850 to 2,295,532 in 1890; milch cows, from 6,385,094 in 1850 to 16,511,950 in 1890; oxen and other cattle, from 11,393,813 in 1840 to 34,851,622 in 1890; swine, from 26,301,293 in 1840 to 57,409,583 in 1890; sheep, not including spring lambs, from 19,311,374 in 1840 to 35,935,364 in 1890. The wool clip of the census year of 1890 amounted to 165,449,239 pounds. The value of live stock increased during the period 1850–1890 from $544,180,516 to $2,208,767,573.

FARM DAIRY PRODUCTS are thus stated in the census of 1890: Entire number of gallons of milk produced on farms, 5,210,125,567; pounds of butter, 1,024,223,468; pounds of cheese, 18,726,818. It must be remembered that the production of butter and cheese on farms has been largely transferred to creameries, whose products are not included in the foregoing figures, but are included in part in the census statistics of manufactures—only in part, however, because it is known that a very large portion of the creameries and their products were omitted from the census statistics of 1890.

POULTRY.—In 1890 it was reported that the chickens on farms numbered 258,871,125; other fowls, 26,738,315; and that the eggs produced and sold during the census year were 819,722,916 dozen. The poultry statistics, however, probably fall far short of the facts.

CROP PRODUCTION.—Coming now to the production of crops, the following extracts are made from the censuses of 1840 and 1890, to which the figures of the Department of Agriculture for 1899 are added:

Cereals.—Production of indian corn, 377,531,875 bushels in 1840; 2,122,327,547 bushels in 1890; 2,078,143,933 bushels in 1899; and the corn acreage increased from 62,368,504 acres in 1880 to 82,108,587 acres in 1899.

The wheat product was 84,823,272 bushels in 1840; 468,373,968 bushels in 1890; 547,303,846 bushels in 1899; and from 1880 to 1899 the wheat acreage increased from 35,430,333 acres to 44,592,516 acres.

The United States produces more wheat than any other country in the world. A comparison may be made for 1898: Crop of the United States, 675,149,000 bushels; France, 371,881,000 bushels; Austria-Hungary, 170,938,000 bushels; Italy, 133,372,000 bushels; Germany, 115,000,000 bushels; United Kingdom, 77,170,000 bushels; Russia in Europe, 404,836,000 bushels; Russia in Asia, 94,000,000 bushels; total Asiatic production, 421,321,000 bushels; total African production, 44,439,000 bushels; total South American production, 72,000,000 bushels.

The oat product was, in bushels, in 1840, 123,071,341; in 1890, 809,250,666; in 1899, 796,177,713. The oat acreage was 16,144,593 in 1880, and increased to 26,341,380 acres in 1899.

The rye product was 18,645,567 bushels in 1840, 28,421,398 bushels in 1890, and 23,961,741 bushels in 1899, with a decrease of acreage from 1,842,233 acres in 1880 to 1,659,308 acres in 1899.

Cotton.—The cotton crop of 1850 amounted to 2,469,093 bales, and the crop increased decennially up to the census of 1890, and almost without a break annually since that year until the enormous crop of 1898–99, which amounted to 11,189,205 bales of considerably heavier weight than the bales of 1850. The cotton acreage increased from 14,480,019 acres in 1880 to the largest acreage yet attained, in 1898–99, which was 24,967,295. The cotton crop of the United States substantially dominates the world market for cotton, its proportion of the world's crop being from 80 to 85 per cent, and practically having little competition within the lines of its own grades and qualities. The State of Texas alone produces more cotton than any foreign cotton-producing country.

Hay.—The hay production amounted to 10,248,109 tons in 1840; to 66,831,480 tons in 1890, and to 56,655,756 tons in 1899; and the acreage increased from 30,631,054 acres in 1880 to 41,328,462 acres in 1899.

Tobacco.—From 1840 to 1890 the production of tobacco increased from 219,163,319 pounds to 488,256,646 pounds, and the acreage in the latter year was 695,301 acres.

Potatoes.—White potatoes are a crop of extraordinary increase, the bushels in 1850 being 65,797,896; in 1890, 217,546,362, and in 1899, 228,783,232. From 1850 to 1890 the production of sweet potatoes increased from 38,268,148 to 43,950,261 bushels.

AGRICULTURAL EXPORTS.

The development of the agriculture of the United States has much more than kept pace with the enormous immigration, increase of population, increase of domestic consumption for food and manufactured products, and for cattle and other domestic animals. It has furnished besides an enormous surplus for export. Only the exports of the principal products can be given briefly:

WHEAT.—The wheat export was 4,272 bushels in 1823; 4,155,153 bushels in 1860, and 139,432,815 bushels in 1899. During the same time wheat flour was exported to the amount of 756,702 barrels in 1823, 2,611,596 barrels in 1860, and 18,502,690 barrels in 1899.

COTTON.—The exports of raw cotton amounted to 173,723,270 pounds in 1823, to 1,767,686,338 pounds in 1860, and to 3,773,410,293 pounds in 1899. The more recent product, cotton-seed oil, had an export of 50,627,219 gallons in 1899, and the export trade in this product has chiefly grown up since 1889.

HAY AND BARLEY.—The hay export is relatively small, amounting to only 64,916 tons in 1899. The barley export also is comparatively small, amounting to 2,267,400 bushels in 1899, although it reached its maximum amount of 20,030,301 bushels in 1897.

Corn.—The corn export was 749,034 bushels in 1823; it was 3,314,155 bushels in 1860, and 174,089,094 bushels in 1899. In addition to the unmanufactured corn exports are the exports of corn meal, and these amounted to 791,488 barrels in 1899; but a large portion of the corn product is consumed by domestic animals, the exports of which are mentioned below.

Oats and rye.—In 1899 the oat export amounted to 30,309,680 bushels, and the oat-meal export was 58,042,505 pounds. In the same year the rye export was 10,140,876 bushels, and the rye-flour export 4,826 barrels.

Animals and animal products.—The following are the exports of farm animals in 1899, the figures representing numbers of animals: Cattle, 389,490; hogs, 33,031; horses, 45,778; mules, 6,755; sheep, 143,286. These numbers have grown during the last twenty-five years from almost nothing.

The exports of beef products amounted to 19,053,800 pounds in 1866, not including preserved meats, and the entire quantity of beef products exported in 1899 was 368,666,638 pounds; in the latter year the beef-tallow exports amounted to 107,361,009 pounds. In 1866 the pork products exported amounted to 97,756,169 pounds, and the number had grown to 1,700,380,357 pounds in 1899. In 1899 the mutton exports amounted to 379,110 pounds.

A large item of export has grown up within a few years under the name of oleo oil, and its export in 1899 aggregated 142,390,492 pounds.

The butter and cheese exports have in late years shown a decline, and in 1899 they amounted, respectively, to 20,247,997 and 38,198,753 pounds.

Tobacco.—For many years tobacco has been a large item of export, and its quantity has substantially remained constant for twenty-five years or so. The pounds of leaf tobacco exported in 1899 were 272,421,295 and the value of the manufactured tobacco exported in that year was $5,179,012.

Wool.—The wool export has rarely reached 1,000,000 pounds, although in 1896 it almost equaled 7,000,000 pounds.

The statistics immediately preceding, as well as the others in this paper, express forcibly and comprehensively, although tersely, the agricultural development through which this country has passed up to the present time—a development which has been unparalleled in the history of the world in its rapidity and magnitude.

FERTILIZERS.

The decade 1840–1850 marks an epoch in the history of agriculture. The world was then making rapid strides in applied science.

Railroads were rapidly extending, ocean steam navigation became established, the electric telegraph came into use, and, what was of great importance in connection with agriculture, the chemical theory of manures came to be understood. "Artificial fertilizers," made according to formulas founded on the chemical composition of the ashes of plants, began to be manufactured, and came rapidly into use. The use of nitrate of soda and superphosphate of lime was becoming common. The rapidity of this growth is perhaps best seen in the rise of the use of guano. Samples had come to Europe early in the century; next a few casks came; in 1840, Liebig, the eminent chemist, brought it into notice, and the South American merchants sold a small cargo that year. The next year some 2,000 tons were imported into Great Britain.

The use of commercial fertilizers has progressed from year to year, until, in 1896, 1,894,917 tons were used in the United States, valued at $37,688,869.

The economic advantages of the use of fertilizers are distinctly shown in an investigation conducted by the Division of Statistics of the Department of Agriculture in 1896. This was a unique investigation of comprehensive character, and was applied to the production of cotton.[1]

Along with the increased consumption of commercial fertilizers, there has been a vastly increasing realization by farmers of the value and utility of barnyard and compost manures, especially in the parts of the country where cattle are kept in stables throughout a large portion of the year. While the average production per acre of various crops has not materially increased for many years past, yet farmers know that they not only must not, but can not, rob the soil of its fertility without restoring the elements that go to make plant growth. In some parts of the country, where the fertility of the soil is materially impaired, it is still the custom to let cultivated land lie fallow for sufficient length of time to increase its fertility, but there is also a large extent of country where this is not done, and where, on the contrary, domestic and commercial fertilizers are liberally used.

Speaking in general for the whole country, the net result of the use of fertilizers, so far, has been mainly to preserve the normal fertility and production of the soil, although farmers' experiences have numerously and extensively established the economic desirability of more intensive agriculture.

EVOLUTION OF VARIETIES OF FOODS FROM PRODUCTS.

There is one prominent feature in the agricultural development of the United States that has received little public attention (a feature which alone is worthy of an extended article), and this is the

[1] See Bulletin No. 16. miscellaneous series, Division of Statistics, U. S. Department of Agriculture, The Cost of Cotton Production.

extraordinary multiplication of the varieties of foods into which farm products have been converted by the slaughterhouse, by the packing house, by the cannery, and by the manufacture of health foods. The effect of all this upon the consumption of numerous farm products has been very considerable, and has, to some extent, revolutionized the diet of the people of this country, and presumably of other parts of the civilized world, especially of people living in cities and towns.

EARLY PRACTICES REGARDING FOOD SUPPLY.

One does not need to go back more than a generation to find the meat supply derived from local farmers and butchers. Indeed, among the great mass of the people living outside of the cities and large towns the fresh-meat supply was a matter of neighborhood borrowing; a farmer slaughtered an old cow, perhaps, and distributed some of the quarters or other portions of the carcass among his neighbors, with the expectation that they would return an equivalent when it came their turn to butcher.

Until comparatively recent years the products of the farm were distributed throughout the year for food consumption in a crude and very restricted sense. Apples and green corn were dried in the sun; indian corn was preserved dry in the crib; potatoes, cabbages, and turnips were kept fresh in the cellar; some beef was dried; pork and beef were pickled in brine; squashes and pumpkins were kept for some time after the harvest without rotting, and so on with a few other products of the farm and garden.

CANNING, PRESERVING, AND REFRIGERATING IN RECENT YEARS.

An immense change in the relation of foods to seasons has taken place within recent years. Fresh beef and mutton and pork and poultry preserved by refrigeration can now be had in all parts of the country from the farms and ranches of the Mississippi Valley, to say nothing of the improved local meat supply. Many of the principal garden products now know no season, owing to the canner and the preserver. The peach and the pear, the apricot and the plum, peas and beans, lentils and green corn and tomatoes, and many kinds of berries—and so on through almost the entire list of the fruit and vegetable products of the farm and garden—are now to be had at all times of the year, not always, perhaps, with the flavor they possessed when gathered from their vines and stalks and trees, but yet with much of their original freshness and flavor.

By means of canning and preserving the farmers' market has been enlarged both in time and space until the market for farm and garden products now extends throughout the entire year, not only to remote parts of this country, but to a large portion of the world.

If a list of the different kinds and descriptions of food were to be presented, it would, because of its magnitude, overtax the patience of the reader. An attempt was made several years ago to prepare such a list for a publisher, and the undertaking had to be abandoned on account of its unexpectedly large proportions and the time, labor, and expense required. In this paper it is proposed merely to give three illustrations of the heterogeneity that has characterized the development of farm products as foods and for other purposes.

BUSINESS OF A PROMINENT PACKING COMPANY.

One of the large Western packing companies with enormous capital and business has been selected to illustrate how the extension of the farmers' market has been promoted and elaborated in recent years. This packing company owns the cars that are used to distribute its products and to collect some of them. It has 500 tank cars for transporting blood and tankage for fertilizers and various animal oils; it has 4,000 cars for transporting dressed beef and 6,500 cars for transporting fruit. From the price lists of this company, sent to its agencies throughout the United States, the following facts are extracted:

The beef carcass is cut into many different parts in various ways, all intended to meet the demands of retailers and consumers, and the different parts so cut, including all of the parts of the animal customarily eaten, number 53. With regard to meat cuttings, the numbers are, pork 29, mutton 12, veal 5; number of boiled hams 6; varieties of sausages 43 and of delicatessen sausage 14—total varieties of sausage 57. The dried salt meats are prepared with 16 different cuttings; the bacon meats with 16.

There are hams of many descriptions, and dried beef, mess pork, mess beef, pickled beef tongue, pork spareribs, mince-meat in packages of numerous sizes, lard, compound lard and lard oil, neat's-foot oil, and tallow oil.

The canned meats include numerous varieties, among which may be mentioned corned beef, pigs' feet, gelatin, boar's head, Oxford sausage, tongue, roast beef, boiled beef, chipped beef, deviled ham, potted ham and tongue, minced ham, chicken, turkey, chile con carne, pork and beans, ox marrow, chicken tamale, and sauerkraut and Vienna sausage, etc.

There are to be mentioned also some of the canned soups, as ox tail, mock turtle, tomato, consommé, chicken, beef, mutton, vegetable, purée of green peas, and so on.

The extracts of beef are liquid and in tablets of various descriptions. The pickled tongues, pork hocks, and pigs' feet are of nine descriptions, and there is poultry of all sorts and fresh eggs and canned eggs, ducks, quails, venison, prairie chickens, pigeons, squabs, and even frogs' legs.

COTTON SEED.

Cotton seed is a very marked instance of a former by-product of the farm which has become of enormous value and of varied uses.

The meats are made into oil cake and oil meal for feeding stuff and for fertilizers; into crude oil, cotton-seed stearin, salad oil, cottolene, miners' oil, and soap, and the oil is exported to Europe and brought back again as olive oil. The hulls may be used for making paper; they are made into bran for cattle food; they are used for fuel, and are an important contribution to the list of fertilizers.

Here is an enormous source of wealth which science has given to the farmers within comparatively recent years. The estimated value of the cotton seed of a 10,000,000-bale crop of cotton (to the planters) is about $30,000,000, and this value is now almost entirely appropriated by them.

DIVERSIFICATION OF DAIRY PRODUCTS.

Only one more instance of the elaboration of the products of the farm need be mentioned to illustrate how varied the farmers' market has become and how minutely his products have been made to create and answer the wants of mankind. The following are the varieties of the dairy products of the United States, as furnished by Maj. H. E. Alvord, chief of the dairy division, Bureau of Animal Industry:

Butter.

Dairy and Creamery: In tubs, boxes, family packages, rolls, and prints.
Imitation Creamery: Ladled, Renovated, or "Process," all melted and rechurned.
Fresh or "Sweet;" that is, unsalted.

Cheese.

I. Hard: (*a*) Domestic varieties:
- Factory Standard, or Cheddar.
- English Dairy.
- Young America.
- Little Favorites. }
- Picnics. } Differing in size and form rather than in character.
- Ponies. }
- Skim cheese.
- Pineapple.
- Sage.

(*b*) Foreign forms, imitated:
- Swiss, or Gruyere.
- Edam.
- Gouda.
- Limburger.
- Munster.
- Brick.

II. Soft: Pot cheese, or smearcase.
- Neufchatel.
- Cream.
- Isigny.
- Brie.
- Camembert.
- Potted and prepared cheese, "Club-house," etc.

Milk, etc.

Condensed milk, sweetened.
Condensed milk, plain, or unsweetened.
"Evaporated cream."
Cream, sterilized and canned.
Milk and cream, Pasteurized, "Certified," "Modified," etc.
Koumys, Matzoon, Wheyn, etc.

SOME ECONOMIC RESULTS OF MACHINES.

Much remains to be said with regard to the evolution of agriculture in the United States, but only a brief reference can be made to some of the more important results of the investigation of hand and machine labor and processes as applied to agriculture, with a contrast between farming as it was practiced fifty to seventy years ago and farming as it is now carried on with the advantage of the labor-saving and perfecting implements and machines of the present time as well as with the improvements contributed by the chemist, the "book farmer," and the more enlightened experience of the last half century.[1]

CORN CULTIVATION AND HARVESTING.

Between 1855 and 1894 the following changes took place in the cultivation of corn. The time of human labor required to produce one bushel of corn on an average declined from 4 hours and 34 minutes to 41 minutes, and the cost of the human labor to produce this bushel declined from $35\frac{3}{4}$ cents to $10\frac{1}{2}$ cents.

In the earlier years the plow and harrow of that period were used; the check rows were marked with the shovel plow; the seed was dropped by hand from a bucket or pouch carried by the farmer and covered with a hoe; the cultivating was done with a shovel plow; knives were used for cutting the stalks from the ground by hand; husking pegs were worn on the hand in husking; the stalks, husks, and blades were cut into fodder with an old-time machine turned by hand, and the corn was shelled by hand, either on a frying-pan handle or on a shovel or by rubbing the cob against the unshelled ears.

A radical change had taken place in 1894. The earth was loosened with a gang plow, and a disk harrow very thoroughly pulverized it. A corn planter drawn by a horse planted the corn, and the top soil was pulverized afterwards with a four-section harrow.

When it came to harvesting the corn, a self-binder drawn by horses cut the stalks and bound them, and the shocks of stalks were then hauled to a machine, which removed the husks from the ears, and in the same process cut the husks and the stalks and the blades into fodder, the power of the machine being supplied by a steam engine.

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[1] Report of the United States Department of Labor on Hand and Machine Labor. 1898.

Then came the shelling of the corn, which is one of the marvels of the changes that have been wrought by machines. In this case, the machine operated by steam shelled 1 bushel of corn per minute, while in the old way the labor of one man was required for 100 minutes to do the same work.

WHEAT CULTIVATION AND HARVESTING.

The use of steam as a substitute for horse power in plowing, in harvesting, and in thrashing wheat has not materially contributed to economy, except from a saving due to the elimination of animal power, so the more common power supplied by horses is here selected for the comparison. The years in contrast are 1830 and 1896.

It is one of the marvels of the age that the amount of human labor now required to produce a bushel of wheat from beginning to end is on an average only 10 minutes, whereas, in 1830, the time was 3 hours and 3 minutes. During the interval between these years the cost of the human labor required to produce this bushel of wheat declined from $17\frac{3}{4}$ cents to $3\frac{1}{3}$ cents.

In the contrast thus presented the heavy, clumsy plow of the day was used in 1830; the seed was sown by hand, and was harrowed into the ground by the drawing of bushes over it; the grain was cut with sickles, hauled to a barn, and at some time before the following spring was thrashed with flails; the winnowing was done with a sheet attached to rods, on which the grain was placed with a shovel and then tossed up and down by two men until the wind had blown out the chaff.

In the latter year, on the contrary, the ground was plowed and pulverized in the same operation by a disk plow; the seed was sown with a mechanical seeder drawn by horses; the reaping, thrashing, and sacking of the wheat was done with the combined reaper and thrasher drawn by horses, and then the wheat was ready to haul to the granary.

HAYMAKING.

Hay is the next selection for comparison, the years being 1860 and 1894. When men mowed the grass with scythes, spread it and turned it over for drying with pitchforks, when they raked it into windrows with a hand rake, cocked it with a pitchfork, and baled it with a hand press, the time of human labor required per ton was $35\frac{1}{2}$ hours; but when for this method was substituted a mower, a hay tedder, and a hayrake and hay gatherers and stackers drawn by horses, and a press operated by a horse, the time of human labor was reduced to 11 hours and 34 minutes, while the cost of human labor from the earlier to the later year was reduced from \$3.06 to \$1.29.

The more noticeable economy in haymaking is in the mowing and curing of the grass. In these two operations the time of human labor declined per ton from 11 hours to 1 hour and 39 minutes, while the cost of the human labor declined from $83\frac{1}{3}$ cents to $16\frac{1}{4}$ cents.

The comparisons might be extended throughout many of the crops produced by the farmer, with a constantly recurring illustration of the saving of human labor and of the diminution of the cost of production by the dimunition of human labor. With regard to animal labor alone it often appears that an increased time is required in production, but where there is an increased cost it is principally due to the increased value of the labor of animals.

SAVING IN THE COST OF PRODUCING CROPS.

The potential saving in the cost of human labor on account of improved implements, machines, and processes, at the rate per bushel or ton, as the case may be, has been computed for seven of the principal crops of 1899; the comparison is between the old-time methods of production, in which hand labor was assisted only by the comparatively rude and inefficient implements of the day and the present time, when hand labor has not only the assistance of highly efficient and perfected implements and machines, but has been considerably displaced by them. The saving in the cost of human labor in cents, per unit of product, permits a very forcible statement of its equivalent in money by means of a computation consisting of the multiplication of the saving per unit into the crop of 1899. The result expresses the potential labor saving in the production of seven crops of that year, and is not an aggregate of the saving of human labor in the cost of producing the crops for all of the years between the earlier and the later ones, during which time this economizing and displacement of human labor has taken place. In the case of the crop of corn, the money measure of the saving of human labor required to produce it in 1899 in the most available economic manner, as compared with its production in the old-time manner, was $523,276,642; wheat, $79,194,867; oats, $52,866,200; rye, $1,408,950; barley, $7,323,480; white potatoes, $7,366,820; hay, $10,034,868.

The total potential saving in the cost of human labor for these seven crops of 1899, owing to the possible utilization of the implements, machines, and methods of the present time, in place of the old-time manner of production, reaches the stupendous amount of $681,471,827 for this one year.

CONCLUSION.

It would be idle to claim that the progress of the agriculture of the United States and its evolution from the primitive scope and conditions in which it was found by the settlers who came from Europe have been set forth adequately, even in its important topics and details, in the foregoing pages, but perhaps enough has been presented to explain in their main features the causes and opportunities which in combination have led to an agricultural production actually too great to be grasped by the human mind.

As great as has been the growth of manufactures, mining, the fisheries, and trade and transportation, all of which tend to draw population from agriculture, yet more than one-third of the population of the country is engaged in agriculture or dependent upon agriculturists. This element in our population has proved to be a strong one. It has been conservative with regard to those things that experience has demonstrated to be good. It has been an industrial element upon which all other elements of the population have needed to depend as the cornerstone of the social and industrial structure.

The agricultural element is the one independent element in our society. Let whatever betide that may, this element has a degree of independence in subsistence and in living that no other element has, and still, as in the past, remains the chief mainstay of the nation.

SOIL INVESTIGATIONS IN THE UNITED STATES.

By Milton Whitney,
Chief of Division of Soils.

INFLUENCE OF TRANSPORTATION FACILITIES ON POPULATION AND FARM CROPS.

The nineteenth century opened with the civilized communities of the United States confined principally to the Atlantic seaboard and along the most important rivers, where easy water communication could be utilized in transporting farm products to the cities and foreign countries. This necessarily restricted farming to what are now called the Atlantic Coast and Gulf States, but it is an interesting fact that this area contains a greater variety of soils, ranging from the most fertile limestone valleys to the most barren sands and clays, than can be found in an area of equal size in any of the more recently settled portions of the country. The most important cities of that period were situated at the fall line of the rivers for the advantages of water power in manufacturing and manipulating farm products on one side of the city, and of water transportation to various markets on the other side. About 1836 the Chesapeake and Ohio Canal was completed for a distance of about 65 miles from Washington, D. C., thereby opening up a large territory by placing it in easy communication with the coast. About this time also the Erie and other canals were completed, and the possibilities of extension began to be considered. With the wide introduction of railroads, between 1850 and 1870, the possibilities of general and close connection between the products of Western and inland soils and the Eastern cities and foreign countries became fully apparent.

The gold discoveries of California in 1849 stimulated the interest and led to the construction of the transcontinental lines of railways, which have brought the Pacific coast into closer touch with the Atlantic seaboard than Ohio and Kentucky were at the beginning of the century; while the effect of steamship transportation furnishing rapid, sure, and safe delivery of agricultural products to foreign countries at very reduced prices has been to open up the markets of the world and make it possible to dispose of the vast quantities of goods produced in excess of the requirements of domestic markets.

EARLY WESTWARD MOVEMENT IN SEARCH OF NEW SOILS.

At the beginning of the century (and even before) it was noticed that the soils, particularly of Virginia and Maryland, were losing in fertility. With this deterioration of the soils and the effect of competition from the rapidly increasing population, together with the naturally restless spirit of a certain class among the settlers, a westward movement set in along the fertile limestone areas of western Maryland, the Valley of Virginia, and the limestone areas (blue-grass region) of Kentucky and Ohio. It speaks wonders for the intelligent appreciation of the natural fertility of the soil by the pioneers of those days that these areas were first settled, which are even now considered the most fertile and most valuable for general agricultural purposes. The leading politicians and statesmen of the time, imbued with the European ideas of intensive cultivation, opposed this extension and discouraged the tendency to diffusion, which was becoming so apparent. There were political reasons which weighed even more with them, but it is an interesting fact that these ideas were held by such men at this period. The old Maryland and Virginia families, who, as a rule, were devoted to their homes, contributed but slightly to this extension, only a small proportion of the population of those States being adventurous and restless enough to move West and there open up wild and difficultly accessible tracts.

The products of the soils of Kentucky, Tennessee, and Ohio, which began to take a place in the commercial world early in the present century, were shipped by water to New Orleans.

EFFECT OF RAILROAD EXTENSION ON CROPS AND VALUES.

The Western extension of the railroad, which opened up the virgin prairie lands of the West, where the cost of production is much less than in the Eastern States, and where farming operations are of enormous proportions, has had the effect of forcing specialization upon the Eastern farmers. Some of the most worthless soils have become of great value for certain crops, while some of the most fertile soils have depreciated in value. Other soils have been abandoned from inability to compete with the Western prairies, and the present lack of any special crop or interest peculiarly adapted to them.

The influence of the railroads in providing easy, rapid, and cheap transportation from the fertile prairies of the West and the extraordinarily rapid settlement of the country have been far more potent in the present distribution of farm crops and land values than the exhaustion of the Eastern soils through continuous croppings of nearly three centuries.

EARLY USE OF FERTILIZERS.

As before stated, the deterioration of the lands in the older States was giving no little concern both to statesmen and land owners at the beginning of the present century. It was very generally believed, and is even yet held, that the continuous cultivation of tobacco was very seriously impoverishing the soil. This must have been alarming, indeed, as tobacco had been the most important crop of the colonies, yielding a large part of the revenues, and even passing as currency by legislative enactment for nearly two centuries.

The ideas at that time regarding the requirements of plants and the office of the soil in plant production were exceedingly crude. It had long been a matter of dispute whether the soil furnished any essential ingredients of plants. While these matters did not begin to be clearly understood until Liebig's remarkable generalization of the mineral theory of plant growth in 1840, in the elaboration of which our modern theory and practice of fertilization have been built, it is a mistaken impression that fertilizers were not used before Liebig's time for the increase of crops and the maintenance of soil fertility. On the contrary, they had been used for a long time. The excrement of animals had been used from the earliest historic times. It is stated that the Indians put fish in hills of corn when planting in order to increase the yield, and they taught our earliest settlers to do likewise. Guano had been used from the very earliest times by the Peruvians, and its richness and wonderful effects were observed by Humboldt in 1806.

Lime, plaster, and marl had long been used on the soil, and were earnestly advocated by agricultural writers. In 1817 superphosphates were manufactured for the first time in England, and other substances had been tried with varying success for restoring and maintaining the fertility of the land.

DEVELOPMENT OF THE USE OF FERTILIZERS.

It was not, however, until Liebig's work on the mineral theory of plant growth that the exact requirements of the plants and the important office of the soil began to be fully appreciated. The vehement discussions to which Liebig's work gave rise led to a critical study of the requirements of plants and the availability of soil constituents by Boussingault, Lawes and Gilbert, and others. Between 1865 and 1873 the foreign experiment stations took up the matter and made a critical study, by means of water-culture and sand-culture experiments, on the exact requirements of plants for mineral nutrients. The results of this work have laid the foundation for the development of the present enormous industry of the manufacture and sale of commercial fertilizers in this country.

In 1840 the first ship load of Peruvian guano was sent to England for use as a fertilizer on lands. In 1842 a company was organized and the trade in this substance was regularly commenced. Guano quickly spread in popular favor in this country, and it came to be used very extensively upon the tobacco soils of Virginia and Maryland. After twenty or thirty years of continual usage, it was very generally believed that the tobacco lands had been injured by its use. The guano, it was supposed, stimulated the plant to such an extent that other food materials in the soil were used up faster than they were made available through the natural process of weathering, and, the plants suffered in consequence.

The Peruvian guano was used principally for its ammonia. The West Indian guanos, which came in later, were found to be rich in phosphates and better adapted and safer for some crops than the Peruvian.

Ground bones and boneblack were almost the only other sources of phosphoric acid until 1867, when the South Carolina rock phosphates were introduced. In this year six tons of this rock phosphate were put upon the market. The mining of this South Carolina product rapidly increased until the year of largest production in 1889, when 541,645 tons were produced. The Florida phosphates were developed as a commercial product about this time, and still later the extensive deposits in Tennessee were discovered and mined.

Wood ashes had been used for a long time with remarkable success, but without the knowledge that the success depended largely upon their potash content. They were indeed the principal source of supply of this element until the Stassfurt potash salts were introduced about the year 1860; since this time the Stassfurt salts have been the principal and almost the only source of supply of potash in concentrated forms for crops.

In 1860, in the report upon the geology of New Jersey, Cook called attention to the wonderful richness and effect on the soils of that State of the greensand marls due to the potash and especially the phosphoric acid content. Ruffin likewise called attention to the marls of Virginia, and taught some valuable lessons on the manipulation and care of fertilizers.

The trade in nitrate of soda began between 1830 and 1840. Animal excrement and fish had long been used, as already stated; and these, with the refuse from the large modern slaughterhouses, together with sulphate of ammonia from the gas works, are still the main sources of supply of nitrogen for crops.

After the early work of Johnson, who had been a student of Liebig, the great commercial value of fertilizer analysis and control became apparent, and, after the practical results attained by the German experiment stations recently established, it is no wonder that on the establishment of the first experiment station in this country, at Middletown, Conn., and in the other stations, which rapidly organized, the subject of fertilizer control became the most popular and really the most important subject taken up. The early investigations of the German experiment stations between 1865 and 1873 in water and sand culture and the subsequent pot and field experiments determined the essential elements of plant food likely to be deficient in available form in the soil, and these have been mined or manufactured in various forms; but the rule for the mixing of these for various crops or for different soils has been and is yet very largely empirical.

Many very elaborately planned and well executed field experiments with fertilizers on various soils and with many crops have been carried on in this country during the past twenty-five years, but, owing to the varying character of the seasons and to other conditions not clearly understood, the results have been conflicting and impossible to interpret.

The Cornell experiment station carried on some of the earliest of these field investigations, then the Massachusetts station, the New Jersey station, and many others. Atwater carried out a most elaborate series of field experiments with fertilizers for a number of years through the cooperation of farmers in many of the States. McBryde also carried on a most interesting series in Tennessee and another in South Carolina. Atwater found that the requirement of any particular crop varies greatly, not only with the locality, but with the climatic conditions. Results on one soil were likely to be entirely reversed on another, even with the same crop, and on the same soil from one season to another, and this has been the general experience in nearly all such work.

CHEMICAL INVESTIGATION OF SOILS.

The discussion of the development of the use of fertilizers has preceded that of the chemical investigation of soils, because, although the latter subject logically comes first, the use of fertilizers has been developed more as the result of practical experience and deductive reasoning from other scientific investigations than as a direct result of the chemical analysis of soils.

It is needless to say that the original expectations and claims of the Liebig school that a chemical analysis of soils and plants would give definite indication of the requirements of a particular soil for any plant have not been realized. There have been too many other factors influencing plant growth, which have not been considered or which have not been clearly understood by agricultural chemists. For example, very little is known about the constitution of silicates or the form in which the plant food is held in the soil, or the nature of the influences affecting the solubility of these substances. Furthermore, the influence on plant development of the various elements of meteorology or their resultant, comprised in the term climatology, are no better understood. Nevertheless, the investigations have added greatly to the store of human knowledge and have given a mass of detail which will undoubtedly form a valuable basis for further generalizations and further lines of research.

GROWTH OF SYSTEMATIC ANALYSIS OF SOILS.

As early as 1820 to 1830 various agricultural surveys were organized in several States, notably in Maine, Massachusetts, New York, and North Carolina, but one of the first official recognitions of the importance of soil analysis was in the establishment, by the legislature of Maryland in 1847, of the position of agricultural chemist for the State, who, among other duties, was required to spend one year in each of the districts and one month in each county and to visit each election district; also to analyze specimens of each variety of soil which might be brought to him or which he might find to exist. This work was continued in a modified form up to 1859, when the survey was discontinued. A number of reports were issued during this period, which, on account of crudeness of the methods of analysis employed, are only of historic interest so far as the analyses themselves are concerned.

In the year 1850 Dr. David Dale Owens, assisted by Dr. Robert Peters, began an extensive chemical examination of the soils of Kentucky in connection with the geological survey of that State. This is really the beginning of systematic work in the chemical analysis of soils in this country. In 1860 Hilgard published his report upon the geology and agriculture of the State of Mississippi, and in 1875 he commenced the series of investigations of the soils of California, which have been vigorously prosecuted ever since. In 1875, in connection with some of Hilgard's results, Johnson pointed out the doubtful utility of the ordinary chemical analysis of soils as an indication of the relation of the soil to plant growth, except in special and rather exceptional cases. He showed in a most forcible manner that an ordinary amount of fertilizer, though sufficient to make a difference between a good crop and a failure, could not be detected in the soil by the most refined chemical means, and he concluded, therefore, that the ordinary chemical analysis, giving only the gross amount of substances dissolved by a mineral acid, could give no true indication of the amount of food in the soil actually available to crops. This conclusion was substantiated by the fact that nearly all analyses by the methods then used indicated an amount of food material, even in the poorest soils, sufficient for many average crops. Notwithstanding Johnson's argument, the chemical work was continued by a few scientists. In 1879 the taking of the Tenth Census provided an opportunity for Hilgard and his colaborers to undertake a very remarkable and valuable series of investigations, including the chemical analyses of the soils of the cotton States, and for Killebrew to collect a large amount of valuable information in regard to tobacco soils of the United States. For forty years Hilgard has been an earnest advocate of the value of the chemical analysis of soils, although recognizing, to a certain extent at least, the influence of physical conditions.

In the Tenth Census, Hilgard, in an article prepared in 1879, summarizes the results of his long experience; but these are of the most general character and adapted only to the most general application.

EFFECT OF CHEMICAL RESEARCH ON SOIL PROBLEMS.

The application of chemical research to the problems of the alkali soils and waters of the arid West have been shown by Hilgard to be of very great economic value. Not only has the character of the waters been determined and settlers been warned of the use of waters containing too much salt for irrigation, but the character and location of the alkali salts in the soils themselves have been shown, and in the case of the worst form of black alkali (sodium carbonate) a remedial measure in the application of gypsum has been pointed out. Drainage has been advocated in all cases where careful use of water, thorough cultivation, and judicious cropping will not protect the crops.

The Alabama geological survey republished in modified form the results of the chemical work on the soils of that State which had been done for the Tenth Census. Since that time several of the other States, notably North Carolina and South Carolina, have likewise republished the census material in modified form. Several of the State geological surveys have investigated the chemical composition of the soils of their States. In 1895 Wheeler began and has since carried on an interesting line of investigation upon the acidity of the Rhode Island soils and the marked value of lime as a corrective for this.

The method of analysis employed by Owens and Hilgard, and which is still followed to a large extent, was to digest the soil for a considerable time with hot concentrated hydrochloric acid. When it became apparent that the results secured by this digestion did not clearly express the relative value of soils for crops, Grandeau's hypothesis was taken up and the amount of plant food contained in the organic matter of the soil was determined. More recently many modifications have been suggested in the use of dilute mineral and organic acids in the effort to find a solvent which will express more exactly the amount of available plant food in the soil. Owens recognized the advisability of this in the use of carbonated water in the digestion of some of his soils. Nothing wholly satisfactory as a method of analysis has yet been worked out.

Hilgard recognized, in his Mississippi work, that plants are often a sure indication of the agricultural value of a soil. In the Tenth Census he states:

> A soil naturally timbered with a large proportion of walnut, wild cherry, or, at the South, with the poplar or tulip trees, is at once selected as sure to be both productive and durable, especially if the trees are large. He (the farmer) knows well that the black and Spanish oaks frequent only "strong" soils, and that the admixture of hickory is a welcome addition, while the occurrence of the scarlet oak at once lowers the land in his estimation, and that of pine still more so. However much opposed to the cocklebur in his fields, he welcomes it as a sure sign of a good cotton soil, as much as though he had seen the latter itself growing for a series of years. * * * Taking for granted the soundness of the principle involved in judging the productiveness and the peculiarities of soils from their natural vegetation, and having gained a large array of additional data from personal observation

in the field, I have then sought to ascertain by close chemical and physical examination of the soils in their natural condition the causes that determined this natural selection on the part of certain species of trees and herbaceous plants, while at the same time observing closely the behavior of such soils under cultivation, their special adaptation, etc.

At the very close of the century the ideas brought out by the development of physical chemistry and the modern theory of solution give promise of many productive lines of investigation, which will undoubtedly greatly extend our knowledge of the chemistry of soils and explain many of the important problems of the distribution of crops and vegetation.

BACTERIOLOGICAL INVESTIGATION OF SOILS.

During the past twenty years bacteriologists have contributed a fund of information in regard to the bacteriological changes in the soil, especially upon the subjects of nitrification, denitrification, and the fixation of free nitrogen by the soils. These had been subjects of investigation by chemists for years, but it was not until the work of Pasteur, on the cause of fermentation and putrefaction in general, that the true basis of this soil work could be comprehended. Since then the subjects of nitrification and denitrification especially have been exhaustively studied. Quite recently the effect of leguminous plants with their tubercles and of cultures from these on the soil has received attention from the State agricultural experiment stations, notably the Alabama station.

This work has not only added to our general knowledge of the constitution and condition of the soils, but it has modified the practice of field culture, has enhanced the value of leguminous crops for green manuring, and is opening up the possibilities of pure bacterial cultures to increase nitrification and promote the fixation of the free nitrogen of the air by the soil. It has shown the most rational and economical methods of caring for and manipulating manures and composts and of applying green manures and nitrogenous fertilizers to the soil.

PHYSICAL CONDITIONS AND SOIL INVESTIGATIONS.

The physical conditions and peculiarities of soils have long been recognized as a potent factor in crop production. The early Romans used to plant their crops in wet soils on high ridges in order to secure sufficient drainage and early maturity. The sea island cotton planters, in the early part of the century, used the same method in a modified form to insure the maturity of the long staple crop within the limits of the growing season. More recently the practice of underdrainage with poles, stones, and tile-drains has supplanted this crude method and has given much more effective results.

UNDERDRAINAGE AND IRRIGATION.

About the middle of the present century the popular craze for underdrainage may be considered to have reached its maximum, but since then there has been enormous development in practice, particularly in the States of New York, Ohio, and Illinois. Shortly after this time the subject of subsoiling, to increase the water-holding capacity of the soil and as a protection against drought, became a popular fad. It was advocated by the agricultural press, and was much practiced in the Eastern States, but the general experience seemed to be that it was at least of doubtful utility on most soils for the staple crops, and did not compensate for the cost and great labor involved. In some cases, especially in horticultural work, it has been of the greatest value. It has recently been very successfully practiced in the soils of the semiarid regions of the West in providing a greater storage capacity for the soils against seasons of drought.

In 1847 the Mormons, driven out of Illinois, settled in Salt Lake Valley, Utah, and started the first systematic attempt at modern irrigation practiced in this country for the production of crops in arid soils. Since then this method of cultivation has been extended almost to the limit of the available water supply of the arid West. Volumes have been written upon the subject of irrigation and the wonderful development in the arid West; and the influence on the commercial world of the crops from the irrigated districts speaks for the success of this method of cultivation under these special conditions. Quite recently the Department of Agriculture has attacked the problems of seepage and alkali in the irrigation districts with the most gratifying success. The alkali soils are being mapped, the source of the alkali determined, the cause of the accumulation of the alkali salts shown, and the rational treatment of the lands to prevent injury and to reclaim abandoned lands pointed out.

TEMPERATURE AND MOISTURE OF SOILS.

Considerable attention has been given in the past twenty years to the study of the temperature of soils. The work was started in this country at the Houghton Farm in New York in 1882. It was taken up by the Geneva experiment station in 1883, by the North Carolina station in 1886, and by the Maine experiment station in 1889. Since then considerable work has been done by the experiment stations of Indiana, Michigan, and other States. A great amount of statistical data has been obtained and some few rather unimportant generalizations have been made, but the subject is extremely difficult and complicated, and much of the data has not yet been interpreted.

The North Carolina experiment station recognized the influence of moisture on the temperature of soils and the very much greater influence of the changing moisture content during the growing season than the normal differences in temperature. This subject was therefore taken up as of paramount importance. This moisture work was continued at the Maryland experiment station and later was considerably developed by the Department of Agriculture.

In the Department of Agriculture an electrical method of moisture determination has been devised, and a large amount of data collected and published showing the relation of some of the important types of soil to crops and the influence of soil moisture on the distribution of crop interests. It has been shown that this is a factor in climatology. It is believed that this work has been carried as far as is justifiable without a very wide extension of the work in the line of climatology, which circumstances have not warranted.

TEXTURE OF SOILS.

The mechanical composition, or texture, of soils was studied by Hilgard and many analyses were published by him in the report of the Tenth Census and in the bulletins of the California experiment station, but no general conclusions or principles were drawn from the work. In 1891 the Maryland experiment station developed the work, in cooperation with the Department of Agriculture, in the study of the soils of Maryland. In 1892 the Weather Bureau published a report of this work in a bulletin entitled "The physical properties of soils in their relation to crop production," in which it was shown that there was a relation between the texture of the soils and the crops and agricultural interests adapted to the land. This had been recognized to a certain extent in the specialization of the truck farming on the light sandy soils of the coastal plains, but these soil investigations showed that nearly all the soil types which differed in agricultural value and adaptation to crops differ also in texture and physical properties to an extent which might reasonably account for the existing conditions.

Since then the investigations of the Department of Agriculture of the truck soils of the Atlantic coast and of the soils of the principal tobacco districts, as well as other less complete lines of investigation, show very strikingly the influence of the texture and physical properties of soils on crop production. The commercial type and grade of tobacco and the adaptation to cigars, cigarettes, pipe smoking, chewing, or export, are dependent partly upon the climatic conditions and largely upon the texture of the soil.

SOIL MAPS.

Hilgard published an agricultural map of Mississippi in 1860 showing the distribution of the soils of the State. This was based principally upon the distribution of the native vegetation, especially upon the forest trees. Following out this idea, soil maps of all the cotton-producing States were published in connection with the Tenth Census. Much of this work has subsequently been republished in modified form by the several States and enlarged maps have been issued.

Many general reconnoissances have been made by State geological surveys and by the transcontinental surveys for railroads.

In 1892 the first soil map, based upon the texture and physical properties of soils, was issued by the World's Fair Commission of Maryland, in connection with the handbook of the State prepared at the Johns Hopkins University.

Quite recently the Department of Agriculture has undertaken the survey and mapping of the soils of some of the important agricultural districts of the country. The work is based entirely upon the differences in the texture of the soil as seen in the field, the distribution of vegetation, or such other evidences of the agricultural value as can be obtained in the field. While these field methods are quite independent of laboratory work in the actual preparation of the maps, chemical, physical, and geological laboratories are maintained to investigate the different types of soils, their origin, and exact chemical and physical composition. In 1899 about 720,000 acres were thus surveyed and mapped on a scale of one inch to the mile.

This work includes, as a most valuable feature, the investigation and mapping of alkali soils and the preparation of alkali maps. These later maps are based upon actual field determination of the soluble salts, to a depth of 6 feet or more, by an electrical method and by certain chemical field methods devised by the Department of Agriculture for this work.

IMPORTANT SOIL INVESTIGATIONS AND THEIR UTILITY.

The most important lines of investigation and their probable utility may be briefly summarized. The most pressing need is a more rational and more complete theory upon which to base our system of fertilization. It seems hopeless to expect much from the indiscriminate chemical analyses of soils by the methods at present in use to indicate the actual needs of a soil, save only in exceptional cases. From the preparation of detailed soil maps and the study of large and uniform types of soil, with their slight but significant variations in chemical composition and physical properties, compared with other types having well-marked differences, much may doubtless be learned. The study of the solubility of the soil constituents, the equilibrium between the resulting components, and the disturbances of the equilibrium by the addition of salts and fertilizers of different kinds, together with the absorptive phenomena and diffusion and leaching, is extremely important in view of their bearing upon the needs and the effect of fertilizers. Then, the effect of long-continued cropping, the effect of changing climatic conditions on the crops, the development of the crop itself, and the experience of farmers, if thoroughly investigated, will give suggestive hints of the soil conditions.

The physical investigation of the texture and structure of soils and of the important changes which are known to result from the physical forces acting between the soil grains in all conditions, from a loose loam to a puddled and impervious silt or clay; and the effect on these physical forces and physical properties of fertilizers, cropping, and cultivation, will unquestionably be of economic value.

The relation of soils to moisture and the variation of soil moisture throughout the season, in connection with temperature, humidity, and movement of the air, and the duration and intensity of the sunshine as an essential feature of climatology should be developed to the fullest extent, as they unquestionably play a very important part in the development and distribution of crops. The investigations of the Division of Soils indicate that the time has come when the relation between these factors can be determined and their relation to plant growth can be intelligently studied.

Probably the most important immediate results of practical utility to be derived from these soil investigations are the mapping of large areas in important agricultural districts. In the irrigation districts these investigations point out any source of alkali which is to be feared, the cause of the accumulation, and give a basis for the intelligent underdrainage when necessary to remove the salts and seepage waters. In all cases the maps show the various types of soils, and the reports accompanying them explain the differences in these soils, so far as possible, and describe their characteristics. The greatest value of these maps will be in the possibility of intelligent specialization. When a light loam is seen adjoining a heavier loam or clay the methods of cultivation or cropping should not be alike, and will not be when the farmers realize the importance of the differences in the properties of the soils. It is generally a waste of energy to attempt thus to compete, or use the same methods, or even to grow the same crops oftentime on soils of such different texture. The safest and altogether most practical thing is to recognize the differences in the soils and the peculiarities of each; use each for the particular crop or class of crops best suited to the conditions; then attempt to improve each by the controlling factors, which are quite sure to be revealed in the experience of changing climatic conditions and the development of crops in the course of two or three years. The development of plants is a sure and safe guide generally to an experienced person as to the condition of the soil. This specialization is unquestionably developing in this country as a result of competition and of social conditions, and reliable and detailed soil maps will be the best possible basis for this purpose.

PROGRESS OF ECONOMIC AND SCIENTIFIC AGROSTOLOGY.

By F. Lamson-Scribner, B. Sc.,

Agrostologist.

DEFINITION OF AGROSTOLOGY.

The science of agrostology, strictly speaking, relates only to the true grasses, and an agrostologist is one who has made a special study of these plants; but in the present paper the term is used in a broad sense, and embraces not only the true grasses, but all other pasture and fodder plants. In this broad sense the subject becomes one of the greatest economic importance, in which every citizen of the United States is more or less directly interested; but only its more salient features can be considered in this paper, many interesting minor facts being of necessity wholly omitted. In the present treatment of the subject it has been found convenient to divide it into two parts: First, economic, or applied, agrostology; second, scientific, or systematic, agrostology.

ECONOMIC, OR APPLIED, AGROSTOLOGY.

CONDITIONS PRIOR TO THE BEGINNING OF THE CENTURY.

Prior to 1800 practically nothing had been done in this country in the cultivation of grasses and forage crops. There were comparatively few farms, and the food supply of cattle and horses was chiefly furnished by the natural growth of the indigenous grasses. The great grazing regions of the West were then unknown, and the almost boundless capacity of this country to support cattle of all kinds was not even suspected. The best known hay and pasture grasses were not unknown in those days; timothy, redtop, tall meadow oat grass, orchard grass, crested dog's-tail, and meadow foxtail had been frequently mentioned by agricultural writers for fifty years or more. Schreber, in his great work on grasses, published in 1769, minutely describes and illustrates all the species just mentioned, besides many others, including the now popular smooth brome grass; he notes, too, the special characteristics of each grass, the kind of soil to which it is adapted, and its agricultural value. It is a curious fact, noted also by Schreber, that timothy, a native of Europe, was introduced into cultivation in Europe through seed secured from this country.

CONDITIONS DURING SEVENTY-FIVE YEARS OF THE CENTURY.

Although at the beginning of the present century the list of forage grasses contained many names, very few had been taken up by American farmers; in fact, it does not appear that during the first half of the century any marked progress had been made in the way of cultivating new or improved varieties. A few of the leguminous plants began to attract attention, but the farmers throughout the New England and Middle States were mostly content with timothy and redtop or timothy and clover and apparently cared for little else. The value of clovers and leguminous crops generally for improving the soil was recognized by the more progressive farmers, and improved farming methods were beginning to be practiced by the more intelligent. In the South little attention was paid to grasses, and the planters imported most of their hay supply from the North. The common cattle found sustenance in the natural herbage, and crab grass, the poor man's hay, was as common then as it is now. In the West no attention whatever was paid to the cultivation of forage crops, the rich and abundant growth of grasses which everywhere covered the country at that time seeming to offer an inexhaustible supply for all grazing animals.

FIG. 5.—Big blue stem (*Andropogon provincialis*): *a*, a pair of spikelets; *b*, first empty glume; *c*, second empty glume; *d*, third glume; *e*, fourth, or flowering, glume; *f*, palea; *g*, lodicules.

"Grasses for the South," by Rev. C. W. Howard, is the subject of a valuable paper published in the Agricultural Report of the Patent Office for 1860. Thirty-one varieties of grasses and forage plants suited to the South are described, and in the same paper fifteen economic grasses of Texas are described by Mr. G. Linceeum. The laying down of meadows and pastures and the management of grass lands are also fully discussed.

In 1869 the Superintendent of Gardens and Grounds of the Department of Agriculture, Mr. William Saunders, started a grass garden upon the Department grounds, in which fifty-one varieties of grasses and forage plants were cultivated. The results obtained the first season were published in the Report of the Commissioner of Agriculture for

1869. Further notes in regard to these experiments by Mr. Saunders appear in the Report of the Commissioner for 1870, and in the same report there is a most interesting account of the grasses of the plains and of the eastern slope of the Rocky Mountains. Several of the more important species, including big blue stem, the various gramas, bromes, and fescues are described, and their apparent value commented on. It is claimed that the big blue stem (*Andropogon provincialis*, fig. 5), together with the little blue stem (*Andropogon scoparius*), formed 60 per cent of the grass flora in the Missouri River region and 26 per cent of the grasses in the Rocky Mountain region. The paper in the report of 1870 appears to be the first that treated exclusively of the grasses of the region mentioned from an economic standpoint, and the grasses then noted as being of most value are those attracting most attention to-day.

GRASS AND FORAGE PLANT INVESTIGATIONS.

As early as 1878 Dr. Vasey, the Botanist of the Department of Agriculture, published in the reports of the Commissioner illustrated papers on the grasses and forage plants of the country, and during the entire period of his service, from 1872 to 1893, he continued to give much attention to the subject and to devote much effort to promoting the interests of economic agrostology.

The unwise management and overstocking of the rich grazing lands of the West have forced upon the farmers of that section the necessity of giving attention to the cultivation of forage crops or at least making an effort to preserve those grasses which have not already been destroyed. The cattle ranges of the Southwest were the earliest to suffer from overstocking, and it was to this region that the Department of Agriculture first directed its attention along lines of grass and forage-plant investigations. In 1886 the Botanist of the Department drew attention to the enormous loss of cattle in the Southwest through overstocking of the ranges and lack of protection from storms in winter. In Bulletin No. 3 of the Division of Botany, published early in 1887, there was presented a report on certain grasses and forage plants for cultivation in the South and Southwest. In this report we find lengthy accounts of carpet grass, hairy-flowered Paspalum, guinea grass, crab grass, Texas millet, etc. This was the first work of the kind published by the Department, and owing to the very complete and practical treatment of the subject, it at once excited a good deal of interest among the farmers and ranchmen of the region it was designed to cover; and it set them to thinking about improving their hay lands and pastures. During the year 1887 the Botanist carried on field investigations through western Texas, New Mexico, Arizona, Nevada, and Utah, the results of which were published in Bulletin No. 6 of the Division of Botany. An enumeration of the grasses of Texas was published in 1890 in Vol. II of the "Contributions from the U. S. National Herbarium." The most comprehensive economic work published by the Department on grasses and forage plants was issued in 1889 under the general title of the "Grasses and forage plants of the United States, by Dr. George Vasey, with an appendix, giving the chemical composition of grasses, by Clifford Richardson." This work contains 114 full-page plates, illustrating the various grasses and forage plants described, and is essentially a revised and enlarged edition of a similar report published in 1884, under the title "Agricultural grasses of the United States."

During the year 1888 the results of the investigations in the arid regions the two previous seasons bore fruit in the way of securing from Congress an appropriation for the establishment of a grass experiment station at Garden City, Kans. This was the first effort of the kind receiving governmental support. The tract selected for this station contained 240 acres, and experiments were carried on there for five years, from 1888 to 1893. The results accomplished were on the whole satisfactory, and were given in detail in the Reports of the Secretary of Agriculture for 1891, 1892, and 1893.

There have been a number of works on grasses and forage plants published by private enterprise during the last half of the present century. These works, being widely read, have played no insignificant part in diffusing a knowledge of the plants of which they treat, and doubtless they have had a direct influence in improving American agriculture. Among the more important of these publications, the following may be mentioned: "The grasses of Wisconsin," by Dr. I. A. Lapham; "The grasses and forage plants of Tennessee," by J. B. Killebrew, published in 1878; "Grasses and forage plants," by C. L. Flint, an illustrated work of nearly 400 pages; "A handbook of the grasses of Great Britain and America," by J. Henderson; "Farmer's book of grasses and other forage plants for the Southern United States," by D. L. Phares; "Grasses and their culture," by J. S. Gould, 212 pages and 74 plates, published in the Report of the New York Agricultural Society for 1869; and the first volume of Beal's "Grasses of North America," which includes chapters on the physiology, composition, selection, improving, and cultivation of grasses and clovers.

During the past twenty years great progress has been made in the introduction of new forage plants and improved methods of forage production and feeding. Probably the greatest advance has been made in the use of silage and soiling crops and in the increased production of leguminous plants. The agricultural press of the country, the numerous publications of the State experiment stations, and the various bulletins and reports issued by the Department of Agriculture, have all helped to bring about these improved conditions, until to-day our country leads all others in the art of applied agrostology.

ESTABLISHMENT AND WORK OF THE DIVISION OF AGROSTOLOGY.

A new impetus was given to the work of applied agrostology in the United States by the establishment, in 1895, of a division in the

Department of Agriculture devoted exclusively to the investigation of grasses and forage plants. The recommendation for the establishment of such a division was made by the Secretary of Agriculture in his Annual Report to the President for 1894, as follows:

The forage interests in the United States are vast in value. Seventy million tons of hay are cut and cured each summer. This crop is taken from 50,000,000 acres of land. Each year's hay crop is estimated to be worth $600,000,000. No accurate means have been found for ascertaining the cash value of grasses upon pasture and other lands that are grazed. It is known, however, that these lands support and fatten vast herds of cattle, sheep, and horses. In 1890 such ranges in the United States fed 14,059,030 head of domestic animals. As these millions of animals subsist largely upon native grasses and other forage plants, the magnitude of these figures elucidates the vital necessity of securing, if possible, new and better forage plants in this country. * * * Therefore * * * it is proposed to create a new division in this Department [Agriculture], as provided in the estimates submitted herewith, to be called "The Division of Agrostology." * * * If the hay production in the United States, as a result of this effort in behalf of agrostology, is raised only 1 per cent, it is equal to an increase of $6,000,000 per year in the value of this single farm product.

The law passed by Congress, in accordance with the above recommendation, establishing the Division of Agrostology, provided for field and laboratory investigations relating to the natural history, geographical distribution, and uses of the various grasses and forage plants and their adaptability to special soils and climates; the establishment and maintenance of experimental grass stations; the collection of seeds, roots, and specimens for experimental cultivation and distribution; the preparation of drawings and illustrations for special purposes, as well as illustrated circulars of information, bulletins, and monographic works on the forage plants and grasses of North America. This law authorized work along technical, or systematic, lines, as well as lines of applied, or economic, agrostology. It made possible greater concentration of purpose and more systematic effort than had before existed, and gave due recognition to an agricultural subject of the greatest importance to the entire country. It afforded means for a wider distribution of the knowledge already gained by the Department and the State experiment stations, and rendered possible the undertaking of new lines of research and closer cooperation with experiment stations and individuals in future investigations. Immediately upon the establishment of this new Division, plans were laid for a vigorous and systematic prosecution of the work along the lines indicated in the act of Congress. In a country of such vast extent and varied character as the United States, there were necessarily many problems relating to the forage supply that demanded the attention of the Agrostologist, and the range of investigations, embracing both purely botanical work and the more practical questions relating to methods of cultivation, adaptation of varieties to local conditions, and the factors governing the forage supply of the different sections of the country, opened a broad and interesting field of labor.

INVESTIGATIONS IN THE WEST.—One of the first subjects to engage the attention of the Agrostologist was the cause of the depletion of the Western stock ranges and the best means of restoring the grasses which had been destroyed by overstocking. Preliminary work was at once undertaken through studies in the field and by the establishment of grass gardens at Washington, D. C., and elsewhere, and by instituting cooperative work with individuals and State experiment stations. During these investigations the more important regions concerned were visited, leading stockmen and farmers were consulted, and data secured concerning soil and climatic conditions relating to forage problems, distribution and value of the native grasses and forage plants, the existing conditions of the stock ranges, the best methods of growing grasses and forage crops, and other questions pertaining to forage production. It soon became evident that one of the most effective means for ascertaining the best methods of restoring or improving the ranges would be the establishment of stations at typical points, where tests could be made with drought-resisting grasses and forage crops, and where general methods of range improvement could be practiced. Such stations were established in 1898 in Texas—one at Abilene and one at Channing. Another station was carried on at Knoxville, Tenn., in cooperation with the experiment station of that State, and early in 1899 arrangements for cooperative work with the experiment station of South Dakota were effected, and a station established at Highmore. Other station work has been done in cooperation with Western railroads at points in eastern Washington.

The field investigations carried on by the Division in the West have been in the States of Montana, Wyoming, Colorado, the Dakotas, Nebraska, Iowa, and Texas. From this work in the West, which is still being carried on, the following publications have directly resulted: "Grasses and forage plants of the Rocky Mountain region," Bulletin No. 5; "Grasses and forage plants of the Dakotas," Bulletin No. 6; "Grasses and forage plants of Iowa, Nebraska, and Colorado," Bulletin No. 9; "Grasses and forage plants of Central Texas," Bulletin No. 10; "Grasses and forage plants and forage conditions of the Eastern Rocky Mountain region," Bulletin No. 12; "The Red Desert of Wyoming and its forage resources," Bulletin No. 13; "Grazing problems in the Southwest and how to meet them," Bulletin No. 16, and Circulars Nos. 21 and 23, the former being the first report on the experiments at Highmore, and the latter dealing with the results of the work at Abilene.

GRAZING AND FORAGE PROBLEMS IN THE SOUTH.—The grazing and forage problems in the South are of great importance. Keen competition is forcing the planters to adopt more diversified systems of agriculture. Four hundred species of grasses occur in the Southern States, and there are broad areas in these States which may profitably be devoted to meadows and pastures. While investigations have been going on in the West, a study of those grasses most likely to succeed and at the same time meet the needs of stock raisers and dairymen in the South has been made a feature of the work of the Division, particular attention having been given to the native forage plants and the best methods to be employed in maintaining or improving the existing pastures and forage supplies. In cooperation with the experiment station at Knoxville, Tenn., already referred to, trial cultivation of many varieties of grasses and other fodder plants has been made. Field work has been carried on in the States of Mississippi, Louisiana, Alabama, Georgia, Florida, North Carolina, and South Carolina, and a large amount of material of both botanical and practical interest has been gathered by direct observation or through correspondence. Several bulletins bearing upon this work have been published. The first bulletin issued by the Division was "Notes on the grasses and forage plants of the Southeastern States," and the following is taken from the introduction to this bulletin:

Very few plants are widely cultivated in the South for hay or pasturage, the farmer relying for the most part upon the wild grasses. These may be roughly divided into two classes, the first comprising introduced grasses, mostly annuals, which spring up on cultivated land after the regular crops have been removed; the second, native grasses, the majority perennials, which make the bulk of th pasturage. Of the first class, by far the most important, is crab grass (*Panicum sanguinale*), which forms a great part of the volunteer hay crop of the South Atlantic and Gulf States. With it are often associated crowfoot or barn grass (*Eleusine indica*), little crowfoot (*Dactyloctenium ægyptiacum*), pigeon grass (*Setaria glauca*), and, in the far South, spur grass (*Cenchrus echinatus*), and Mexican clover (*Richardsonia scabra*). Of the native, perennial grasses, perhaps the most important belong to the genus *Paspalum*, Louisiana grass (*Paspalum platycaule*) being the most common and best known. *Panicum serotinum* is also a valuable pasture grass over extensive areas. The broom sedges (*Andropogon* species), early in the season, make the bulk of the grazing on thin, dry soils. Three other widely known forage plants, belonging to neither of these classes, must be mentioned. Johnson grass, dreaded as a weed, yet esteemed as a forage plant, is an introduced perennial grass, highly valued for hay. Japan clover (*Lespedeza striata*) is perhaps the most valuable pasture maker, for the largest area, in the Southern States, while both for hay and for grazing Bermuda is king among grasses throughout the South.

Other publications relating to the work done in the South are "Forage plants and forage resources of the Gulf States," Bulletin No. 15, published in 1896; and "Southern forage plants," Farmers' Bulletin No. 102, published in 1899.

INVESTIGATIONS ON THE PACIFIC SLOPE.—The grasses and forage plants of the great region west of the Rocky Mountains, constituting the Pacific slope, have from time to time received some attention from the Department of Agriculture, but the first systematic work of investigating the plants of that region was begun in 1898, when the Agrostologist visited the more important localities, noting the physical conditions of the soil and natural forage resources. Throughout the drier sections east of the Cascades the capacity of the cattle ranges has been much reduced through drought and overstocking and the forage problems there are very similar to those in western Texas and Wyoming, and can be met by similar methods. Experimental work with grasses and forage plants was begun in 1898 in cooperation with the Northern Pacific Railroad and the Oregon Railroad and Navigation Company. The preliminary report on this work has been published as Circular No. 22 of the Division of Agrostology.

Special Investigations.—Aside from the general work of investigation of grasses in their relation to the forage supply of the country, special studies have been made on individual species, such as cowpeas, sorghum, millets, saltbushes, vetches, etc., concerning which special papers or reports have been issued by the Department. Investigations have also been carried on relative to the adaptability of grasses to special uses, such as the formation of lawns, the binding of soils subject to wash, and the holding of drifting sands. Careful studies have been made of the grasses used in various parts of the country for lawns, and the results of this work were published under the title of "Lawns and lawn making" in the Yearbook of the Department for 1897. The question of texture and color, so important in the making of a perfect lawn, were discussed in that paper, and illustrations introduced showing diversity of texture between several varieties of grasses which have been used as lawn grasses. In the United States there are long stretches of country bordering the Atlantic and Pacific coasts, and even along the shores of the Great Lakes, which are covered with drifting sands. These shifting sands are not confined to the shores of these great bodies of water, but frequently occur along the river banks and at various points in the interior of the country. In some cases the drifting of these sands is a serious menace to profitable agriculture, and along the coasts and rivers there is often danger to navigation, resulting from the shifting of large bodies of sand by the winds or waves. A few grasses have been found which may be utilized in effectually binding these shifting and destructive sands. The results of the discoveries and investigations made along these lines were published in the Yearbook of the Department for 1898 in an illustrated article on "Sand-binding grasses." One of the most recent discoveries of the Division in the way of sand-binding grasses is the seaside blue grass (*Poa macrantha*), which grows in the sands along the Pacific coast of Oregon and Washington, where it is often seen covering the summits of the highest dunes. It is an excellent sand binder, and possesses the advantage over beach grass in having more tender leaves and stems, which render it of value for grazing. It has the habit of sending out slender lateral branches, which, lying prostrate on the sand, extend 4 to 6 feet or more from the parent stock, and as these readily develop roots at the joints, the grass is rapidly propagated over considerable areas. If available for cultivation in the interior, seaside blue grass will prove a most valuable acquisition for cultivation in very sandy soils. The important subject of forage plants for cultivation on alkali soils is discussed in a paper from the Division in the Yearbook of the Department for the same year (1898), and in the Yearbook for 1895 is a paper on the "Grasses of salt marshes," the result of a previous year's investigation of the marshes along the coasts.

SOME VALUABLE GRASSES AND FORAGE PLANTS.—Some of the grasses and forage plants which the Division of Agrostology has recommended or to which special prominence has been given in its experimental work on account of their value for agricultural and other purposes are here given, as follows:

Blue grasses.—The blue grasses, of which Kentucky blue grass (*Poa pratensis*) may be considered the type, are among the most valuable species for pasturage, and some of them are unexcelled for hay. Kentucky blue grass is useful for both purposes, and is one of the most widely distributed species of the genus. In the United States it ranges from Maine to the Gulf, westward to the Pacific Ocean, and northward to Alaska. Some of the forms present qualities of unusual excellence, and the Division is giving attention to the selection of these for improving our forage supply. In the Rocky Mountain region are many species of Poa; a few of these the Division has experimented with to some extent, and so far quite satisfactory results have been secured, Wyoming blue grass (*Poa wheeleri*, fig. 6) being found one of the best. Its habit of growth is not unlike that of Kentucky blue grass, but it is probably much better able to survive long periods of drought than is that species. Smooth bunch grass (*Poa lævigata*) is another species of the blue-grass class common in the Rocky Mountain region. Mutton grass (*Poa fendleriana*) is one of the best grasses of the mountain

FIG. 6.—Wyoming blue grass (*Poa wheeleri*): *a*, empty glumes; *b*, *c*, florets.

ranges of New Mexico and Arizona. Nevada blue grass (*Poa nevadensis*) is a fine variety occurring in the Rocky Mountain regions of Montana and Colorado, some forms of it extending westward to the Cascades. It promises to be a very productive hay grass, and trials are being made with it having that in view. Sand blue grass (*Poa leckenbyi*) is a newly discovered species of eastern Washington, and is remarkable in growing in almost pure sand under conditions where the well-known Eastern grasses would fail entirely. It is hoped that this grass will prove to be not only a good sand binder but a good grass for very sandy soils and sandy areas in which other crops have failed. It is undoubtedly an excellent sand-binding species, and if it finally proves successful in the interior it will serve the double purpose of holding drifting sands and furnishing excellent forage.

FIG. 7.—Western wheat grass (*Agropyron spicatum*): *a*, empty glumes; *b*, florets.

Lyme grasses.—The lyme grasses present a number of varieties of special interest, and seeds have been collected of several of them. In some sections, Canadian lyme grass, or a form referable to that species, promises to be a most productive hay grass. It has been tried by the Division in Texas and at the stations in the Northwest. Woodland lyme grass (*Elymus glaucus*) is a common grass in Montana, Washington, and Oregon, and promises to be of some agricultural value. Giant lyme grass (*Elymus condensatus*) is a tall, rank-growing species of the Pacific slope, extending eastward to Montana. It is one of the dry-land grasses, and may prove of considerable value for hay or grazing in the drier regions of the Northwest. Yellow lyme grass (*Elymus flavescens*) and small sand lyme grass (*Elymus arenicolus*) are species of Oregon and Washington which are excellent natural sand binders. Along the Columbia

River the spontaneous growth of the sand lyme grass has in many cases effectually checked the drifting of the sands which are blown out from the river bed. Both of these species deserve careful consideration by those who are endeavoring to prevent the blowing of destructive sands.

Wheat grasses.—The wheat grasses are characteristic grasses of the Northwest. Western wheat grass (*Agropyron spicatum*, fig. 7), known to many of the ranchers as bluestem, is one of the best native grasses for hay, and efforts are being made to extend its cultivation. Meadow wheat grass, a closely allied species, is also a promising native variety. Bunch wheat grass (*Agropyron divergens*) may be classed as first among the dry-land species. It grows naturally in exceedingly dry soils and where the annual rainfall is very light. This wheat grass and the two feather grasses (*Stipa viridula* and *Stipa comata*), common to the same region, are the most promising species for regrassing the overstocked ranges.

Fig. 8.—King's fescue (*Festuca kingii*): *a*, spikelet; *b*, floret.

Blue grama and side-oats grama.—Blue grama (*Bouteloua oligostachya*), known also in some sections of Montana as buffalo grass, is one of the pasture grasses among our native species. It is readily propagated by seed and thrives in almost any soil. It has been grown at all of the stations and by many volunteer experimenters. It apparently does as well in Washington, D. C., in the heavy clay soils as in the light and dry soils of eastern Washington. Side-oats grama (*Bouteloua curtipendula*) has a wider natural range, and although making a turf inferior to that of blue grama, it is nevertheless an excellent pasture grass, and under favorable circumstances yields an abundant hay crop.

Fescue grasses.—The mountain districts afford many native species of fescues. Creeping fescue and sheep's fescue exist in many varieties, some of them possessing great points of excellence. Aside from these two species there are others of equal value. King's fescue (*Festuca kingii*, fig. 8) is one of these. It is a native of Colorado, and it has been successfully propagated by seed, which it yields abundantly. Buffalo bunch-grass covers extensive meadows in Montana, affording excellent grazing, and is occasionally cut for hay, being very productive. It grows to the height of 3 or 4 feet, and its introduction into agriculture will be a test of its merits under cultivation.

FIG 9.—Smooth brome grass (*Bromus inermis*): *a*, spikelet; *b*, flowering glume seen from the back; *c*, floret seen from the anterior side, showing palea.

Brome grasses.—Native brome grasses are well worth more attention than has been given them. They seed abundantly, the seed is easily harvested, and germinates readily. The Division of Agrostology has tried several of the Western species, and from the limited experiments made, it is evident that there are important grasses in this group. *Bromus pumpellianus*, a native of Montana, Colorado, and Wyoming, is hardly to be distinguished from the European smooth brome (*Bromus inermis*, fig. 9), the introduction of which has done so much to improve the stock interests of the country.

The above list might be greatly extended, for there are many species as deserving of notice as those here mentioned. Bulletin No. 14 of the Division of Agrostology treats of the economic grasses and gives an extended list of the same.

Forage plants.—There are many forage plants which do not belong to the order Gramineæ. The greater proportion of these, and those which are generally regarded as the most valuable, belong to the Leguminosæ, or family of legume-bearing plants, which includes the clovers, vetches, beans, peas, lupines, etc. There are seventy varieties of native clovers, ninety lupines, forty vetches, and half as many wild beans, from among which doubtless selections can be made of varieties possessing special qualities superior to any of those now cultivated.

The leguminous forage crops, which now play such an important part in agriculture, were made the subject of a paper from the Division in the Yearbook for 1897. The cultivation of these plants is increasing every year, and their great value as soil renovators and cheap producers of fodder, rich in nitrogenous compounds, is becoming more and more widely known and appreciated. Referring briefly to the history of the cultivation of these plants, the writer of the paper in question states:

> The oldest cultivated forage plants and the best for enriching the soil are those of the clover family. Not one of the now well-known hay or pasture grasses has been cultivated more than three hundred years, while a number of leguminous crops have been grown for forage from prehistoric times. The chick-pea, or gram, dates back full thirty centuries. It is to-day one of the leading grain crops and soil renovators of Spain, India, and central Asia.
>
> Alfalfa, which is recognized as the best forage plant in the semiarid Western States, or wherever dependence must be placed upon irrigation, was cultivated by the Romans at least two hundred years before the commencement of the Christian era. The soy beans have been grown in China and Japan and lentils in Hungary from prehistoric times. The field pea, originally from northern Italy, was introduced into cultivation eight or ten centuries ago. Sainfoin was grown in France and red clover in Media during the early years of the fifteenth century, and white, or Dutch, clover in Holland at the beginning of the eighteenth century. Sulla, which is largely grown in southern Italy and northern Africa, and which seems to be admirably adapted to well-drained soils in Florida and the Gulf States, was first introduced into cultivation in 1766. The cowpea has been known in this country nearly as long as sulla. Alsike, or Swedish clover, was taken up as a forage about thirty years later, while during this century and within recent years a score or more of valuable legumes have been brought to the attention of the farmer, and hardly a year passes that new ones are not added to the list.

One of the most recently introduced and promising of the leguminous plants is the velvet bean, a native of India. Its range of profitable cultivation is limited to the Southern States. The velvet bean is fully described and illustrated in Circular No. 14 of the Division of Agrostology.

The saltbushes of this country are very numerous in variety and often cover extensive areas in the far Western States and Territories. Their value to the stockmen of the West is clearly set forth in Bulletin No. 13 on the "Red Desert of Wyoming and its forage resources," and a number of both the native and introduced species are described in Farmers' Bulletin No. 108, which is devoted exclusively to them. It is only within the last few years that the forage value of these plants has been recognized in this country, and their importance in increasing our forage supply is fully treated of in a paper on "Forage plants for alkali soils," in the Yearbook for 1898, as already noted. It is for reclaiming or rendering valuable for grazing purposes soils highly impregnated with alkali that these plants are especially useful. The following is from the paper just referred to:

> The saltbushes and salt sages, both introduced and native, have proved to be of value in all alkali-impregnated soils. A more extended cultivation of saltbushes is recommended throughout the West, and while trials are being made with the Australian species, the native forms, many of them being fully as leafy and having as succulent herbage, should not be overlooked. It is probable that quite a number of the thirty or more salt sages and saltbushes that grow wild on the high plains, mesas, and deserts of the West would, if only given an equally favorable opportunity, prove to be as well adapted to cultivation as any of the foreign species. As the West is developed the amount of grazing land is each year decreasing and the extensive areas of alkali-impregnated soils are becoming more valuable. The increase of these soils in value in the estimation of the Western cattle growers will come through the use of saltbushes and other alkali-tolerant forage plants.

Through the Division of Agrostology the Department has distributed the seeds of a number of the native saltbushes and quantities of several of the Australian species, the one receiving the most attention being the Australian saltbush (*Atriplex semibaccata*). Seed of this species was introduced into this country nearly twenty years ago by the California experiment station at Berkeley, but it has been only within the last year or two that it has received any widespread attention. During the present season large quantities of the seed have been distributed by the Secretary of Agriculture in regions where this saltbush is likely to prove most useful in the way of increasing the forage resources of our country.

VOLUNTEER EXPERIMENTERS.—Much of the work done by the Division of Agrostology in testing the adaptability of varieties to the prevailing conditions in different sections of the United States has been carried on in cooperation with farmers and stockmen as well as with a number of State experiment stations. These tests or experiments have been made chiefly by sending the experimenters seeds of the grasses or forage plants which have been collected or obtained by purchase, and requesting that reports be made as to the success or failure of the attempts made to grow them. Nearly ten thousand packages of seeds, including two hundred and fifty-five varieties, have been sent out in this way to those expressing their willingness or desire to cooperate with the Division. The reports received on account of this method of seed distribution during the past three years have been prepared for publication as Bulletin No. 22, which will serve to illustrate very well what can be accomplished in acquiring a practical knowledge of grasses and forage plants through volunteer experimenters. These experiments have proved of great value, not only as being the means of finding out the suitability of varieties for cultivation in different sections of the country, but also of bringing the work of the Division in closer touch with the people whom it is designed to serve. The results of these tests have shown that many of the valuable native grasses adapt themselves readily to cultivation, and have also demonstrated the value of some of the newly introduced varieties, as well as the possibility of a wider cultivation of many of those already commonly grown in the United States. Thus, it has been discovered that slender wheat grass and a number of the native bromes and blue grasses can be utilized in the formation of artificial meadows and pastures; that other of the wheat grasses, the grama grasses, blue grasses, and native fescues may be utilized in reclaiming the worn-out ranges in the drier sections of the country; that smooth, or Hungarian, brome grass, recently introduced from the Old World, is a most valuable hay and pasture variety for the drier sections of the West and Northwest; that Australian saltbush, as well as a number of native saltbushes, is well adapted to cultivation on lands strongly impregnated with alkali, such as are found in many parts of the Southwest; and the experiments now in progress seem likely to demonstrate the value of other varieties in certain sections, such as oasis alfalfa for the hot, dry Southwest, and Turkestan alfalfa for the dry sections of the Northwest where the climate is colder.

Some results of work of Division of Agrostology.—The Secretary of Agriculture, in summing up the work of the Division of Agrostology in 1898, said:

> Through the efforts of this Division we are learning the needs of the several sections of the country and the forage problems they have to meet. We are acquiring a better knowledge of the distribution and value of our native grasses and forage plants, as well as the peculiar conditions of soil and climate best suited to their growth.

The discovery of new economic grasses or new and valuable forage plants, the adaptability of the native species to cultivation, the introduction of forage plants into new or untried regions, the application of species to new or special uses, and the general diffusion of knowledge through publications and correspondence respecting these plants are among the important results of the work of the Division.

Extension of investigations.—Through the Division of Agrostology the Secretary of Agriculture is working not only to produce more and better hay on every acre of meadow land, but also to preserve or improve the great cattle ranges of the West and the pasture lands of the whole country. In the Report of 1899, the Secretary says:

> The investigations under way in the Gulf-coast region and on the Pacific slope ought to be extended in their scope; the work on range improvement should be continued along the present practical lines; the investigations looking toward the preservation and improvement of our most valuable native grasses and forage plants should be continued; the study of soil and sand-binding grasses ought to be extended to include experiments as to the adaptability of our native sorts to practical use for fixing the shifting sands of our coasts and for holding embankments in place, as well as to the introduction of desirable foreign sorts; investigations relative to the introduction, cultivation, and management of improved

pasture and forage crops on the worn-out farms of the East should be undertaken; the question of forage crops suitable to alkali soils is one of much importance to certain sections of the country, and should receive full and careful investigation.

APPLIED AGROSTOLOGY IN THE STATE AGRICULTURAL EXPERIMENT STATIONS.

Nearly all the State experiment stations, ever since their organization in 1887, have given more or less attention to the subject of grasses and forage plants, and a few of them have made this a leading feature of their work. Among the first to undertake work along these lines was the California experiment station at Berkeley, and this station, under the direction of Prof. E. W. Hilgard, has done very much toward the introduction of valuable forage plants into that State by the distribution of seeds of many varieties. Other stations which have given special attention to grass and forage-plant investigations are those in Nebraska, South Dakota, Tennessee, Mississippi, Alabama, Ohio, Connecticut (Storrs), Kansas, Michigan, New York, Minnesota, and Massachusetts.

Over two hundred bulletins and reports have been issued by the several stations on the subject of grasses and forage plants—a fact which in itself demonstrates the great interest taken in these investigations and the manifest importance attached to the subject. Some of the stations have published descriptive and illustrated grass floras of the States in which they are located, which have done much toward disseminating a knowledge of grasses and inciting greater interest in the improvement of forage resources. One of the most complete and elaborate of these floras is that published by the Tennessee station, in which all the grasses known to occur within the State are illustrated.

The effect of the grass and forage-plant investigations which have been carried on by the Department of Agriculture during recent years, together with similar investigations at the different State experiment stations, is seen at the present time in the changed methods of farming that are being practiced in many sections of the country. This is well illustrated in the South, where but a few years ago it was thought by many that the better cultivated grasses and forage plants could not be successfully grown. It is also illustrated in the improved methods of handling pastures and ranges that are coming into practice in many parts of the West, and in the greater diversity of the grass and forage crops that are grown in almost all sections of the country where dairying is a leading industry.

SCIENTIFIC, OR SYSTEMATIC, AGROSTOLOGY.

At the beginning of the century the number of known North American grasses barely exceeded one hundred species. These had been published chiefly in the works of Linnæus, Lamarck, and Walter. In 1803 Michaux published his "Flora Boreali Americana," in which he describes as new sixty-eight species. Michaux's work was soon followed by those of Persoon, Pursh, Nuttall, Muhlenberg, Elliott, and Beauvois, in which many new North American species were published. Beauvois, in his "Agrostographiæ," undertook to establish a natural arrangement of the whole Gramineæ, with descriptions of the genera then known, together with many new ones, some of which were North American, and the majority of which have since been adopted. Between 1820 and 1850 appeared the great works of Kunth, Trinius, and Nees von Esenbeck, in whose writings, especially those of Trinius, who confined himself exclusively to grasses, many North American species were published for the first time. It was during this period that the great American botanists, Drs. John Torrey and Asa Gray, did much to advance our knowledge of North American plants, and many new species of Gramineæ appear in their various works. These authors, especially Dr. Gray, whose publications continued until a comparatively recent date, made further additions to agrostological science, and their works are essential to the student of grasses to-day.

Steudel in 1855 published the first volume of his "Synopsis Plantarum Glumacearum," which contains a general enumeration of the grasses of all countries, and is the last work in which such an enumeration has been attempted. All the older North American species are included, and Steudel describes many new ones, some few of which are still retained.

The knowledge of Southern grasses was greatly advanced by the publication of Chapman's "Flora of the Southern United States" in 1862. Grisebach, in his "Flora of the British West Indies," published in 1864, described a number of species which come within our southern limits, and in Ledebour's "Flora Rossica," which appeared in 1853, many species common in Alaska are published for the first time. In England, General Munro was for many years the leading authority on grasses, and in this country Dr. George Thurber was the court of last resort in all pertaining to American grasses. The chief contribution to agrostology made by the former was his monograph on the tribe Arundinariæ, and the latter is best known to the student of grasses to-day by his contribution to Brewer and Watson's Botany of California, published in 1880, in which all the species of that State then known were fully described.

A marked impetus was given to the study of grasses by English-speaking students by the publication of Bentham's "Notes on grasses," in 1881, in the Journal of the Linnæan Society. In this work the several tribes and genera are discussed. The classification presented is essentially based upon the opinions of General Munro and finally adopted in the third volume of Bentham and Hooker's "Genera Plantarum," published in 1883. A work of much interest to the student of the grasses of the Southwest is Fournier's "Gramineæ" in his "Enumeration of Mexican plants," published early in the last decade. It is the only work especially devoted to the grasses of Mexico, and includes many species occurring in the States and Territories bordering that country. After the death of General Munro, in 1880, Prof. E. Hackel, of St. Poelten, Austria, was at once recognized as the highest authority on grasses, and his contribution to the great German work on the "Natural families of plants," by Engler and Prantl, is ample evidence of his right to the position. An American translation of this work, under the title of "The true grasses," published in 1890, has done much to promote the study of systematic agrostology in this country. It presents in a clear and concise manner the general features of the grass family, enumerating the best-known economic species, discussing their structure and morphology, and their arrangement into tribes and genera, thus placing in the hands of the American student a manual by which he is enabled to classify any grass which may come into his hand, and materially assisting the systematic study of grasses, which now forms such an important feature in the curriculum of nearly all our agricultural colleges.

In 1889 Hackel published an extensive monograph of the Andropogoneæ, in which all the North American species of that tribe then known are fully described, a few of which are presented as new to science. The system of classification of the tribes and genera of the Gramineæ presented by Hackel in his "True grasses," and now generally adopted in this country, was much modified by Baillon in his "Monographie des Graminées," published in Paris in 1893. This is the latest general treatment of the grass family as a whole that is of special interest to the student of American grasses. In this work not only is there a decided modification in the limitation and arrangement of the tribes and genera from that proposed by Bentham and by Hackel, but an attempt is made to adopt the more advanced system of nomenclature.

Four years ago, in 1896, Prof W. J. Beal, of the Michigan Agricultural College, published the second volume of his work on the "Grasses of North America," wherein are brought together for the first time descriptions of all the North American species known to the author. He enumerates over one thousand three hundred species, including many from Mexico and Central America, with full descriptions. No other single publication covers the same extended field.

SYSTEMATIC AGROSTOLOGY IN THE DEPARTMENT OF AGRICULTURE.

While the Department of Agriculture has always been more or less active in promoting the interests of applied agrostology, it has in later years been hardly less energetic in advancing scientific knowledge of grasses and developing a wider interest on systematic lines. Immediately following the publication of the third volume of Bentham and Hooker's "Genera Plantarum," already referred to, Dr. George Vasey, then Botanist of the Department, published as a special report a list of the grasses of the United States, together with a synopsis of the tribes and genera, which were chiefly translated from Bentham and Hooker's work. Two years later, in 1885, a revised and somewhat enlarged edition of this list was published under the title of "A descriptive catalogue of the grasses of the United States." This work included many economic notes, and was prepared with the view of assisting both the scientific student and the farmer. Between the years 1891 and 1893 the Department published two volumes prepared by Dr. Vasey, containing descriptions and full lithographic plates of two hundred species of grasses belonging to the region of the Southwest and the Pacific slope. The illustrations in this work are for the most part excellent and the descriptions are very full. The plan adopted is not unlike that of Trinius's "Icones," and it is a matter of regret that the work could not have been continued until all of the American species were illustrated in the same manner. In 1892 Dr. Vasey published as Part 1 to Vol. III of the "Contributions from the U. S. National Herbarium" what he designated as Part I of a "Monograph of the grasses of the United States." Following the classification of Prof. Edward Hackel this part contains descriptions of all the North American species of grasses known to the writer through the subtribe Phleoideæ in the seventh tribe Agrostideæ. At the time of his death (March 4, 1893), Dr. Vasey had prepared the manuscript of a considerable portion of the second part of this monograph, but the work in the form in which it then appeared has not been continued. During the years between 1881 and 1893 Dr. Vasey published many new species of North American grasses, not only in the bulletins issued by the Department, but in the leading botanical journals and in the proceedings of scientific societies. The total number of species published by him between 1885 and the time of his death was one hundred, and nearly as many new varieties.

Since the establishment of the Division of Agrostology in 1895, systematic work on grasses has been continued by the Agrostologist and his assistants. Papers which may be classed as belonging to systematic agrostology have been published in Bulletins Nos. 4, 7, 8, 11, 17, 18, 19, and in Circulars Nos. 9, 10, 15, 16, and 19 of the Division. Circular No. 15, published July 14, relates to "Recent additions to systematic agrostology," while the other circulars referred to contain chiefly descriptions of new species. Under the general title "Studies on American grasses," to which Bulletins Nos. 4, 8, 11, and 18 belong, there have been published revisions of certain North American genera and enumerations of species collected in the little-known regions, and a large number of species presumably new have been described. In Bulletin No. 19 there was published a very carefully prepared paper on the structure of the seeds of grasses, the investigations being made largely with the view of establishing a basis of classification upon the Caryopsis. Six hundred and twenty-seven North American grasses are figured and described in Bulletins Nos. 7 and 17. The illustrations in these two bulletins are all drawn from original material and form a part of a series which, when complete, will illustrate all of our North American grasses. The Agrostologist has also published in botanical journals and in proceedings of scientific societies many papers bearing on the subject of systematic agrostology, notably among these may be mentioned "Notes on the grasses in the Bernhardi Herbarium, collected by Thaddeus Haenke and described by J. S. Presl," published in the Tenth Annual Report of the Missouri Botanical Gardens. This paper is illustrated by fifty-four plates, drawn from the types of species described by Presl in "Reliquiæ Haenkeanæ." In these various papers and in the publications of the Division, the Agrostologist has during the last five years published one hundred and twenty-five species and thirty-three varieties.

A good herbarium or collection of grasses forms an essential part—is, in fact, the basis of all work in systematic agrostology. The Division of Agrostology, since its organization, has been steadily at work building up an herbarium of grasses, until now the collection numbers nearly thirty-five thousand mounted sheets of specimens, more than twenty-five thousand of which have been added during the past five years. This collection, which forms no inconsiderable part of the great National Herbarium located in Washington City, is especially valuable, not only on account of its richness in North American species, but also on account of its containing a great many types of the species published in recent years.

SYSTEMATIC AGROSTOLOGY IN THE STATE AGRICULTURAL EXPERIMENT STATIONS.

It is believed that the work of the Department of Agriculture in the way of scientific investigation of grasses has done much to develop similar lines of work in the agricultural experiment stations. The work at these stations, in order to meet the demands of the people, must of necessity be more along the lines of applied agrostology. Several of the stations have, however, published descriptions of the grasses of the States in which they are located. In 1894 the Tennessee Agricultural Experiment Station published a bulletin in which all the species known to occur within the State were fully described and illustrated. This work contained keys of analysis to the tribes and genera, and in the larger genera to the species also. Less fully illustrated descriptive bulletins have been published by several other stations, but comparatively little original work has been done by any of them along systematic lines. The Division has lent material aid to this work, not only through its several publications, but by the distribution of many thousands of named specimens of grasses to these agricultural experiment stations. As illustrating the attention now paid to systematic agrostology and the rapid progress being made in this branch of the subject, it may be stated that during the last five years three hundred and seventy-four new species of North American grasses and one hundred and sixty-six new varieties have been published.

PROGRESS OF ROAD BUILDING IN THE UNITED STATES.

By Maurice O. Eldridge,

Acting Director of the Office of Public Road Inquiries.

INTRODUCTION.

The history of road building in the United States parallels in but few particulars the road history of the other great civilized nations of the world, and in many respects our highways bear but slight resemblance to those of the older countries. There is little doubt that had the first settlers arrived in this country when the Roman Empire was at the zenith of its glory our Republic would now be bound together with a perfect system of magnificently constructed highways, but when America was settled by the English, in the early part of the seventeenth century, the mother country was still using those systems in road building which it had inherited from the dark ages.

The Britons neglected the roads which had been made by the Romans, and, failing to build new ones, their country for centuries was provided with only bridle paths, or at most with narrow highways for small carts. These highways were, except in dry weather, practically impassable, and in the sparsely settled districts much of the travel had to be carried on by means of pack animals. The idea of a central control of road systems, which is the only means by which any extended work in this direction has ever been accomplished, had died out in the middle ages and had not at this time been revived. For these reasons the traditions relative to the construction and management of roads which followed the first settlers to this country were practically valueless.

ROAD METHODS OF THE FIRST SETTLERS.

The first settlements in the United States were naturally located along the seashore and upon the banks of navigable streams. Narrow and mysterious Indian trails led from the settlements along the coast to the interior, and aside from an occasional rude path beside some stream or along the coast, these were the only lines of communication up to the end of the seventeenth century. Indeed, for a century after the settlement at Plymouth Rock there were few roads in this country over which goods or passengers could be transported in wagons or carriages.

The little traffic and intercourse that were carried on between the settlements was maintained principally by boats or by horsemen or pack trains over the obscure Indian trails. A systematic attempt at road building was then, of course, impossible, owing to the crude state of society and the sparse population. Soon there was an eagerness to penetrate the vast wilderness of the interior and communicate with settlers in other regions by shorter routes than those afforded by the winding streams. Acting upon this impulse, the pioneer blazed his way through the forests and brambles. He made temporary bridges over the streams by felling large trees across them, and threw brush and poles over the boggy places in his bridle paths. With the steady increase in wealth and population, this "pack-train era" in road building was gradually superseded by original trackways or widened trails and then by wagon roads, but without any attempt at improvement. Another century elapsed before anything like improved highways was established outside the eastern coast districts, and it was not until the beginning of the present century that there were any well-built roads in the rural communities.

ONE OF THE EARLIEST ROADS IN THE UNITED STATES.

The first great American road which the historian tells anything about was laid out in 1711, and ran from New York to Philadelphia. Its antiquity, and the fact that it connected these two cities, gave to it the name "The Old York Road." The opening of roads was an important affair in those days; money was more scarce than it is now, and doubtless it was more of an undertaking to construct roads than it is to build the railways of to-day. By studying the history of the Old York Road we at once realize the potency of the adage that "the history of roads is the history of civilization." The Indian trail, the blazed trees, and the footpath, followed by the bridle road for pack trains, and then the rough roads for carts and wagons, which were subsequently graded and paved, making a more easy means of transportation, are all stepping stones to higher degrees of civilization.[1]

FORCED-LABOR SYSTEM AND ROADS OF THE EARLY COLONISTS.

In the early colonial days the roads were at first built and maintained principally by the use of volunteer aid or free labor. Each town or settlement had what was called a "village green," and in this open place the citizens assembled to discuss matters of public import. At these meetings the care of the poor, the infirm, the deaf mutes, etc., was discussed; the opening of new and the maintenance of the old roads were also among the most interesting subjects of discussion. The citizens would here offer their services free of charge to the community or town for building or maintaining the roads running through or by their lands. These offers to maintain the roads free of charge soon became so limited, however, that the towns were forced to pass

[1] The York Road Old and the New Fox Chase and Bustileton, by S. F. Hotchkin.

ordinances compelling all able-bodied men to "work the road" a specified number of days, or in lieu of such labor to pay a money tax to the pathmaster or road overseer. It is easy to trace progress in all those matters which were discussed on the "village green" save one, and that is the "forced-labor" system of working roads, which exists in most of the States to this day.

The following extract, relating to the early methods of locating and building roads, is copied from a letter dated November 30, 1785, written by George Washington to Patrick Henry, then governor of Virginia:

> Do you not think, my dear sir, that the credit, the saving, and convenience of this country all require that our great roads leading from one place to another should be straightened, shortened, and established by law, and the power in the county courts to alter them be withdrawn? To me these things seem indispensably necessary, and it is my opinion they will take place in time. The longer, therefore, they are delayed, the more people will be injured by the alterations when they happen. It is equally clear to me that, putting the lowest valuation upon the labor of the people who work upon the roads under the existing law and the customs of the present day, the repairs of them by way of contract, to be paid by an assessment on a certain district, until the period shall arrive when turnpikes may with propriety be established, would be infinitely less burthensome to the community than the present mode. In this case the contractor would meet no favor; every man in the district would give information of neglects; whereas negligence under the present system is winked at by the only people who know the particulars or can inform against the overseers, for strangers had rather encounter the inconvenience of bad roads than the trouble of an information, and go away prejudiced against the country for the polity of it.[1]

This system of "working out" the tax was as unsatisfactory in the days of Washington as it is now. Much delay and inconvenience was caused by the deplorable condition of the main roads. The ruts were deep, the hills steep and full of gullies, and when stagecoaches were first used travelers were often compelled to get out and assist the driver in pulling the vehicle out of the mud. Even the roads running out of the large cities and towns were no exception to the general rule; they were often in such wretched condition that passage was rendered difficult and sometimes dangerous. It was no uncommon sight to see the horses floundering in mud up to their haunches.

York road, running out of Philadelphia, was a quagmire of black mud for nine months of the year, and on this road long lines of wagons were every day to be met with drawn up near Logan's Hill, where the wagoners unhitched their teams to assist each other in pulling through the deep sloughs. Sticks or rails were often stuck up to warn travelers out of the quicksand or mud holes, and the fences were sometimes pulled down in order to permit passage through the adjacent fields.[2]

In 1796 the worst road in the country was said to be the one from Elkton, Md., to the Susquehanna Ferry. It was so uneven and full

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[1] Writings of Washington, Vol. XII, edited by J. Sparks.

[2] Watson's Annals of Philadelphia and Pennsylvania in the Olden Times.

of holes that stagecoach passengers were often requested by the driver to lean out the side of the coach to prevent being overturned. "Now, gentlemen," he would say, "to the right;" "Now, gentlemen, to the left."[1]

INAUGURATION OF TURNPIKE ROADS BY CHARTERED COMPANIES.

The making of turnpike roads by chartered companies was inaugurated in the last quarter of the eighteenth century with the advance of population to the West. State and national charters were given to many turnpike companies, which at first yielded large profits to capitalists. The establishment of turnpikes and the maintenance of them by toll, however, effected but little improvement in the general system, and the tax imposed upon those who were compelled to use many of these roads was not paid without protest.

THE WILDERNESS TURNPIKE.

The Wilderness Turnpike was the name of one of the earliest of these roads. From the Shenandoah Valley, in Virginia, it followed for some distance the Holston River; thence it crossed the Allegheny Mountains at Cumberland Gap to central Kentucky. This route was opened at first for pack trains, but afterwards was so improved that it became the main road for wagon trains from Virginia to the valley of the Ohio. A large commerce was carried on between Virginia and the West over this highway, and it proved very advantageous to Kentucky and adjacent States in their early settlement and development. During the first decade of this century the Wilderness Turnpike was the best highway south of the Potomac River; but soon the traffic began to decrease and the revenues became so limited that it was neglected. For years, however, the tollgates were maintained and travelers were required to pay a toll of $2 on passing the gates, which were 70 miles apart, although tools frequently had to be carried in the vehicle with which to repair the portions of the road that were impassable.[2]

THE PHILADELPHIA-LANCASTER TURNPIKE.

The desire to speculate in those days was as great as it is now, and such were the profits of some of these roads that they were often the subject of speculation. A notable example of this is shown by the organization of a company in 1792 to build a turnpike from Philadelphia to Lancaster, Pa., a distance of 60 miles. The charter was secured, and in ten days 2,275 subscribers made application for stock. As this was more than the law allowed, the names were placed in a lottery wheel and 600 were drawn; with these subscriptions the work began. The road builders of that day knew little or nothing regarding

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[1] History of the People of the United States.

[2] N. S. Shaler, American Highways, pp. 19 and 93.

the construction of highways, and the mistakes made on this occasion taught them some valuable lessons. The land was condemned, the trees felled, and the roadbed prepared. The largest stones that could be found were dumped upon it for a foundation, and upon this colossal base earth and gravel were spread; then the work was declared complete; but when the washing rains came deep holes appeared on every hand, sharp stones protruded from the surface, and the horses received scratched and broken limbs as they sank between the bowlders up to their knees. The gigantic error of the road builder was then made plain. Indignation meetings were held, at which the turnpike company was condemned and the legislature blamed for giving the charter. Had it not been for an Englishman who offered to rebuild the turnpike on the macadam plan, as he had seen roads built in the old country, improved road construction would have received a severe blow. The Englishman's proposition was accepted by the company, and he was successful in completing the Lancaster and Philadelphia turnpike road, which was then declared to be "the best piece of highway in the United States—a masterpiece of its kind."[1]

ERA OF SPECULATION AND RESTORATION OF FORCED-LABOR SYSTEM.

The success of the Lancaster pike encouraged road building everywhere, and before the first decade of the new century had elapsed many of the well-settled States were voting money, setting apart revenues derived from the sale of public lands, and establishing lotteries to build turnpikes between prosperous towns in the East and to the frontier. The prospect of increasing their land values by the building of good roads and the fascination of receiving large dividends from investments induced many people to risk their all upon these schemes. Speculation was rife in the land, turnpike building rapidly became the rage, and in a few years a sum almost as large as the public debt at the close of the Revolution was invested by the people in turnpike ventures. By 1811 over 317 pikes had been chartered in New York and in the New England States, their total length being 4,500 miles and their combined capital over $7,500,000. Hundreds of miles of public turnpikes[2] were constructed in New York and in some of the Western States with thick, wide boards or planks, and for a few years it was thought that this method would supersede all others. While the planks lasted the roads were good; but the boards decayed very rapidly, and for this reason the method, proving unsuccessful, was

[1] History of the People of the United States, Vol. II, p. 554.

[2] The term "turnpike" is of medieval origin, having been first used in England to designate a graded road, for the use of which travelers were expected to pay toll. A pike across the road indicated a tollgate, where the traveler was required to stop before proceeding on his journey. After he had paid the fees the pike was turned and he was allowed to go on his way. "Turnpike" has now come to mean any public highway constructed of stone or gravel. As a rule, however, the term is only applied to a toll road or one upon which formerly toll was collected.

gradually abandoned. Except for a few short stretches in the New England and the Southern States, the toll system also proved unsuccessful, and many of the companies lost money. Some surrendered their charters and others were bought out by the States or counties. The turnpike system was gradually superseded by the restoration of the "forced-labor" system, explained elsewhere, and until within the last few years this method was universally followed, each county taking care of its own highways. The States exercised no supervision whatever, and skilled road builders or road engineers were unheard of. The "forced-labor" system was borrowed by our ancestors from the dark ages, and is not unlike the "militia" system adopted in Kentucky and a few other Southern States.

NATIONAL HIGHWAYS.

Early in the present century, with the movement started in England by Telford and Macadam in favor of broken-stone roads, the importance of improved roads for military, postal, and commercial purposes began to be widely appreciated. Road reform assumed such proportions that it was advocated by many of the great patriots of the day; indeed, the movement waxed so strong in this country that it became one of the leading questions of national politics, and was supported by such statesmen as Thomas Jefferson, John C. Calhoun, and Henry Clay. Next to the tariff, it was one of the most important subjects under consideration in Congress.

Those who believed in a liberal construction of the Constitution were favorable to the building of roads by the General Government, while the strict constructionists denied the power of the Government to spend money for any such internal improvements. During President Jefferson's second term the bill admitting Ohio as a State, passed April 30, 1802, contained a provision setting apart 5 per cent of the net proceeds from the sale of public lands in that State to the building of public roads leading from the navigable waters emptying into the Atlantic to and through the State of Ohio—3 per cent for road making within the State and 2 per cent for highways outside the State. Such roads were to be laid out under the authority of Congress and with the consent of the States through which they would pass.

THE CUMBERLAND ROAD.

In 1806 the sale of public lands in Ohio had amounted to over $600,000, and after some discussion in both Houses of Congress a bill appropriating $30,000 was passed. The construction of the so-called Cumberland road was then begun. From Cumberland, Md., it was to extend through southwestern Pennsylvania and over the Allegheny Mountains to the Ohio at Wheeling, W. Va., and then on to St. Louis, Mo. It was constructed after the principles advocated by Telford and Macadam, and was so well built that it is yet a good road, although

FIG. 1.—THE BIG CROSSING ON THE OLD CUMBERLAND ROAD, SUMMERVILLE, PA.

FIG. 2.—OLD CUMBERLAND ROAD APPROACHING CHESTNUT RIDGE MOUNTAINS, PENNSYLVANIA (LOOKING WEST).

it has since passed into the hands of the States in which it is located, and has not been systematically repaired for years. (Pl. XIII.) This road was well described by a writer in 1879, as follows:

It was excellently macadamized; the rivers and creeks were spanned by stone bridges; the distances were indexed by iron mileposts, and the tollhouses supplied with strong iron gates. Its projector and chief supporter was Henry Clay, whose services in its behalf are commemorated by a monument near Wheeling. There were sometimes twenty gaily painted four-horse coaches each way daily. The cattle and sheep were never out of sight. The canvas-covered wagons were drawn by six to twelve horses. Within a mile of the road the country was a wilderness, but on the highway the traffic was as dense as in the main street of a large town. Ten miles an hour is said to have been the usual speed for coaches, but between Hagerstown and Frederick they were claimed to have made 26 miles in two hours. These coaches finally ceased running in 1853. There were also through freight wagons from Baltimore to Wheeling which carried 10 tons. They were drawn by twelve horses, and their rear wheels were 10 feet high.

From Cumberland to Baltimore the road, or a large part of it, was built by certain banks of Maryland, which were rechartered in 1816 on condition that they should complete the work. So far from being a burden to them, it proved to be a most lucrative property for many years, yielding as much as 20 per cent, and it is only of late years that it has yielded no more than 2 or 3 per cent. The part built by the Federal Government was transferred to Maryland some time ago, and the tolls became a political perquisite; but within the past year it has been acquired by the counties of Allegany and Garrett, which have made it free.

From 1810 to 1816 six appropriations, amounting to $680,000, were made by Congress for continuing the work on this road.

PROPOSITION IN CONGRESS FOR A NATIONAL SYSTEM OF ROADS.

In 1817 John C. Calhoun, Henry Clay, and others favored the creation of a new fund for internal improvements. A bill was introduced in the House of Representatives by Mr. Calhoun to set aside for roads and canals the bonus and dividends received by the United States from its newly chartered national banks. In supporting this measure Mr. Calhoun, although a stanch believer in the doctrine of State rights, delivered a speech before the House in which he thus expressed himself:

Let it not be said that internal improvements may be wholly left to the enterprise of the States and of individuals. I know that much may justly be expected to be done by them; but in a country so new and so extensive as ours there is room enough for all, the General and State governments and individuals, to exert their resources. Many of the improvements contemplated are on too great a scale for the resources of States or of individuals, and many of such a nature that the rival jealousy of the State, if left alone, might prevent. They require the resources and general superintendence of the Government to effect and complete them.

But there are higher and more powerful considerations why Congress should take charge of this subject. If we were only to consider the pecuniary advantages of a good system of roads and canals, it might indeed admit of some doubt whether they ought not to be left wholly to individual exertions; but when we come to consider how intimately the strength and political prosperity of the Republic are connected with this subject, we find the most urgent reasons why we should apply our resources to them. Good roads and canals, judiciously laid out, are the proper remedy. Let us, then, bind the Republic together with a perfect system of roads and canals.

The first great object is to perfect the communication from Maine to Louisiana. This may be fairly considered as the principal artery of the whole system. The next is the connection of the lakes with the Hudson River. The next object of chief importance is to connect all the great commercial points on the Atlantic with the Western States, and, finally, to perfect the intercourse between the West and New Orleans. There are others, no doubt, of great importance which will receive the aid of the Government. The fund proposed to be set apart in this bill is about $650,000 a year, which is doubtless too small to effect such great objects of itself, but it will be a good beginning. Every portion of the community—the farmer, the mechanic, and the merchant—will feel its good effects; and, what is of greatest importance, the strength of the community will be greatly augmented and its political prosperity rendered more secure.

Henry Clay also spoke in favor of the proposed act, particularly in reference to its constitutional merits, but the House amended and passed it in such a manner as to enable the States to prosecute the work under the supervision of the National Government, and in this form it passed the Senate. On March 13, 1817, President Monroe vetoed this bill on the ground that he believed it to be unconstitutional, even though its provisions were agreed to by the States. An attempt was made to pass it over the President's head, but failed of the necessary two-thirds majority.

CONGRESSIONAL ACTION REGARDING ROAD BUILDING.

Upon the defeat of the bill for a national system of roads and for the funds for the same, Congress returned to its former method of providing for road building from funds derived from sale of public lands. In 1811, 5 per cent of the net proceeds of the sales of public lands in Louisiana were, as in the case of Ohio, given to that State for the building of roads and levees, in 1816 the same percentage of a similar fund was given to Indiana for roads and canals, and in 1817 a like sum was given to Mississippi for this purpose. In 1818, 2 per cent of a similar fund was given to Illinois for roads leading to that State; in 1819, 5 per cent to Alabama; in 1820, 5 per cent to Missouri, and in 1845, 5 per cent to Iowa. In the meantime the annual appropriations for the Cumberland road, of sums to be replaced from the funds thus set aside in the States through which it passed, were continued. For the fiscal year 1819 over half a million was donated, and on May 25, 1838, the last appropriation, amounting to $150,000, was made, the sum total being about $7,000,000.

While the Cumberland road was being built twelve other great national highways were laid out in the States and Territories, making what was then regarded a complete system of roads, and more or less work was done in opening and constructing them. Congress provided in 1806 for a road from the frontier of Georgia, leading toward New Orleans, La., and one from Nashville, Tenn., to Natchez, Miss.

From 1806 to 1838 a total of $1,600,000 was appropriated by Congress for roads in various places, and of this sum $200,000 was used in Florida; $286,000 was expended for a road from Chicago, Ill., to Detroit, Mich., and other points; $206,000 was also used toward the construction of a road from Memphis, Tenn., to the St. Francis River, in Arkansas. In addition to the appropriations above mentioned, grants of land have been made from time to time by the States to aid in the work, and the labor of United States troops has been occasionally employed.

In 1822 the regular appropriation for the Cumberland road was vetoed by President Monroe, and in 1830 the Maysville and Lexington turnpike bill, authorizing a Government subscription to the stock of a turnpike company in Kentucky, was passed by Congress, but was vetoed by President Jackson.

The monetary crisis of 1837 put a damper on all projects requiring large Government expenditures, and from that time to 1854 only a few small appropriations were made. Another period of activity then began and lasted until the civil war, during which time over $1,600,000 was laid out chiefly on roads in the Territories. From that time to this only a few military roads have been made, and of late years nothing has been done in the way of national aid, save the building of roads in the District of Columbia, in national cemeteries, and on reservations.

INTRODUCTION AND DEVELOPMENT OF STEAM RAILROADS.

The work of building national highways, it will be observed from the foregoing, progressed but slowly, and before much had been accomplished in this direction steam railroads were introduced. It was seen at once that this form of transportation would be far superior to the old method, and many people believed that railroads would eventually do away with the need of public highways. The national highways were, therefore, abandoned, and for several decades thereafter the public roads were almost completely neglected, while private capital undertook the construction of railroads.

The railroad had its birth in the United States on the Fourth of July, 1828. On that day the ceremony of breaking ground for the Baltimore and Ohio Railroad was performed by Hon. Charles Carroll, who was at that time the only surviving signer of the Declaration of Independence. From the small section that was operated at first by horse power has grown a system which places this country in the front rank in the character and extent of its railroads.

The mania for building railroads soon began to spread; speculators again came to the front, as they had done when turnpike building was so popular. Railway lines were projected which, had they all been built, would have far surpassed the number now in actual operation. Seven years after the commencement of the construction of the Baltimore and Ohio, over 1,000 miles of railroads were in operation in the United States, and to-day they penetrate nearly every section of our land.

Thus, the rapid development and extension of railways has, to a large extent, monopolized the thoughts, energies, and finances of the people, and tended to exclude consideration of the no less important source of national development, the public highways.

There must, however, be a limit to the building of railroads. With all our railroads, the transportation problem has not yet been solved. Indeed, the building of so many railroads has made it more necessary than ever that the primary means of transportation, the country road, should be improved. Ninety-nine per cent of all the commerce of the United States which is transported by steam is carried for some distance over the public thoroughfares, and "it costs as much in some cases to haul goods to or from the railway station over the country road as it does to transport by steam the same amount of goods from ocean to ocean or from continent to continent."

DIFFICULTIES OF TRANSPORTATION AND OF TRAVEL.

For many years after the introduction of railroads so little attention was given to the construction and maintenance of the public highways that their condition in most places became even more deplorable than ever. The local roads as well as the interstate turnpikes became practically impassable. As an illustration of these conditions the following facts are cited:

When agricultural machinery began to be manufactured at Walnut Grove, Va., great difficulty was experienced in procuring some of the material which had to be brought from a distance. Neither was it easy, when the machines were once manufactured, to get them to market. Sickles were made 40 miles away, but as there were no railroads and but few highways fit for wagons, the blades, 6 feet long, had to be carried on horseback. It was soon realized that while reapers were luxuries in Virginia and the East, they were a necessity in Ohio and Illinois and on the plains of the great West. When it was discovered that the West was the natural market for these agricultural machines, the next and most difficult question was that of getting them there. The question was finally solved by shipping the first consignment, in 1844, by wagon trains from Walnut Grove to Scottsville, Va., then down the canal to Richmond, thence by water down the James River into the Atlantic and around Florida into the Gulf of Mexico, thence by way of New Orleans up the Mississippi and Ohio rivers to Cincinnati, Ohio.[1]

When Charles Dickens visited America in 1842 he had occasion to travel by stagecoach from Cleveland to Sandusky, Ohio. His

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[1] Men of Achievement, Inventors, by P. S. Hubert, jr.

FIG. 1.—THE ROLLED FOUNDATION OF AN OBJECT-LESSON ROAD BUILT AT HOT SPRINGS, VA., UNDER THE AUSPICES OF THE OFFICE OF PUBLIC ROAD INQUIRIES OF THE DEPARTMENT OF AGRICULTURE.

FIG. 2.—FINISHING TOUCHES TO THE SAMPLE ROAD BUILT AT HOT SPRINGS, VA., UNDER THE AUSPICES OF THE OFFICE OF PUBLIC ROAD INQUIRIES OF THE DEPARTMENT OF AGRICULTURE.

description of part of this journey can be used here to good purpose in describing the condition of many of the public roads of that day:

At one time we were all flung together in a heap at the bottom of the coach, and at another we were crushing our heads against the roof. Now, the coach was lying on the tails of the two wheelers; and now it was rearing up in the air in a frantic state, with all four horses standing on the top of an unsurmountable eminence. * * * The drivers on these roads, who certainly got over the ground in a manner which is quite miraculous, so twist and turn the team about in forcing a passage, corkscrew fashion, through the bogs and swamps, that it was quite a common circumstance on looking out of the window to see the coachman with the ends of a pair of reins in his hands, apparently driving nothing, or playing at horses, and the leaders staring unexpectedly at one from the back of the coach, as if they had some idea of getting up behind. A great portion of the way was over what is called a corduroy road, which is made by throwing trunks of trees into a marsh and leaving them to settle there. The very slightest of the jolts with which the ponderous carriage fell from log to log was enough, it seemed, to have dislocated all the bones in the human body. It would be impossible to experience a similar set of sensations in any other circumstances, unless, perhaps, in attempting to go up to the top of St. Paul's in an òmnibus. Never, never once that day was the coach in any position, attitude, or kind of motion to which we are accustomed in coaches. Never did it make the smallest approach to one's experience of the proceedings of any sort of vehicle that goes on wheels.

This description also serves to illustrate the condition of the country roads, except in a few wealthy communities, twenty or twenty-five years ago. Kentucky was famous for her fine roads a generation ago. Even before the Eastern States had made any decided progress in this direction the State of Kentucky aided the construction of turnpikes by large county and State appropriations. Few States have been more liberal in promoting the building of better highways than Kentucky. The wretched condition of the country roads as well as the ever-increasing need for better ones did not, however, begin to attract widespread attention until something over ten years ago, but, although the movement is yet young in years, the agitation has already led to a general crusade which foreshadows thorough reformation.

ESTABLISHMENT OF THE OFFICE OF PUBLIC ROAD INQUIRIES.

Some road reformers think, as thought many of the founders of the Republic, that the General Government should aid in the building of the principal roads. This idea, however, has met with little encouragement; but out of the agitation has grown a law, passed by Congress in 1893, providing for an office in the Department of Agriculture to collect and disseminate information on the road subject, to conduct investigations, inquiries, and experiments regarding road materials and road construction, and to encourage, by object lessons and otherwise, the building of better roads. (Pl. XIV.) Twenty bulletins and thirty-three circulars containing information of great value to good-roads reformers as well as to good-roads builders have been published by the Office of Public Road Inquiries, and the usefulness of such a good-roads propaganda seems to have been fully demonstrated.

PROGRESS OF THE MOVEMENT IN THE STATES FOR GOOD ROADS.

More than half the States have passed new and progressive road laws, and many hundreds of miles of good roads have already been built under the influence of the new conditions of administration, finance, and construction. The general trend of legislation enacted in these States is as follows: More rigid provisions for carrying out the old systems without radical change in the systems themselves; more liberal tax levies; substitution of money tax instead of labor; local assessment, according to benefits, for the construction of new roads; construction by townships, counties, and districts, with power to issue bonds; State highway commissions; provisions for working convicts; regulations compelling and encouraging the use of wide tires; State aid to road building; construction of State roads.

New Jersey was the first State to take any radical step toward the improvement of her public highways. Her State-aid law was passed in 1891. It provides that on petition of the owners of two-thirds of the lands bordering any public road, not less than a mile in length, asking that the road be improved and agreeing to pay 10 per cent of the cost, the county officials shall improve the road, one-third of the expenses to be borne by the State, if the road is brought to the standard fixed by the State commissioner of public roads, and the balance ($66\frac{2}{3}$ per cent) by the county. The State's expenditures for such improvements in any one year are limited to \$150,000, while the county is limited to one-fourth of 1 per cent of its assessed valuation. At this rate the law makes possible the expenditure of \$450,000 a year, and at \$3,000 per mile this builds 150 miles of road. Ten miles of road were built in 1892, 25 miles in 1893, 60 miles in 1894, and since 1895 the applications for new roads have been far in excess of the limit prescribed by law. (Pl. XV.)

Under this law about 450 miles of improved road have already been built in New Jersey, the State's portion of the expense being about \$715,800. The counties and towns have built out of their own treasuries 450 more miles, which brings the total mileage of improved roads for the State up to 900. These roads cost at first about \$6,000 per mile, but on account of the reduction in the price of materials and the increase of labor-saving machinery the cost has been reduced to about half this amount. The farmers, who at first strongly opposed the law, are now equally enthusiastic for it, and more roads are being petitioned for than can possibly be built in many years out of the limited State appropriation. The system seems to be popular with all classes, and it is being carefully considered by the legislatures of other States. Its principles have been adopted by Massachusetts, Connecticut, Rhode Island, New York, and California. These laws, of which State aid is the principle feature, are regarded by the active advocates of road reform as affording a satisfactory solution of the problem.

FIG. 1.—TYPE OF ROAD IN NEW JERSEY BEFORE IMPROVEMENT.

FIG. 2.—TYPE OF ROAD IN NEW JERSEY AFTER IMPROVEMENT.

FIG. 1.—TYPE OF ROAD IN MASSACHUSETTS BEFORE IMPROVEMENT.

FIG. 2.—TYPE OF ROAD IN MASSACHUSETTS AFTER IMPROVEMENT.

Massachusetts, like New Jersey, also has adopted a system of road improvement which, it is believed, will result in a few years in securing to that State highways that will be second in excellence to none in the United States and equal to some of the best in the Old World. The State has a permanent highway commission, consisting of three persons. Each year this commission is allowed to spend $600,000 for building and maintaining roads, which are called State roads. The law provides that not more than 10 miles of road can be built in any one county in a year and that within six years after the construction of any State road the county in which the road is situated must pay to the State one-fourth of the money expended. Nearly 300 miles of excellent roads have been built in Massachusetts under this new system, the average cost per mile of which was about $9,000. (Pl. XVI.)

Connecticut has made rapid progress in building highways during the last five years. It now has a highway commission, which was provided in 1895–96 with $450,000 and in 1897–98 with $400,000 for road improvement. In 1895–96 the State paid one-third the expense of constructing the roads, the town one-third, and the county the remainder, but in 1897–98 the State increased its part of the expense to one-half, the other half being borne by the towns. The amount of work accomplished is shown by the fact that in the two years last named the entire State appropriation was applied for by the towns, and this was done without any county assistance.

Although the Rhode Island commissioner of highways does not favor State aid, as adopted in the adjacent States, the legislature has at his suggestion passed a law which enables him to build a half-mile sample of good macadamized highway in each town. These permanent object lessons are of great benefit to the towns where good highways have not been built, and are conducive to more liberal appropriations for new roads, as well as more thorough construction, when the local authorities choose to carry the work forward. Out of 2,240 miles of highways in Rhode Island, about 500 miles have been improved by the use of gravel or stone.

The legislature of New York passed a bill last year which provides that the State's share in the improvement of highways shall be 50 per cent of the cost, the county's share 35 per cent, and the town's share the remainder. The boards of supervisors are given the right to decide what roads, if any, are to be improved, thus making the matter of road improvement entirely optional. No new offices were created, the State engineer being placed in charge of all road work. The law seems to give satisfaction; several miles of new roads have been built, and work is still in progress, under its provisions.

The legislature and people of California have not been idle in the work for good roads nor blind to the needs of the State in this respect. Up to a few years ago some of the convicts had been supported in comparative idleness at the expense of the State, while others had been utilized in direct competition with free labor. In 1895 the legislature decided, at the suggestion of Gen. Roy Stone, to utilize convict labor in preparing road materials; a bill was passed providing for a highway commission and for the construction of a rock-crushing plant on one of the State prison grounds. Since that time the convicts have been turning out upward of 100,000 tons of crushed trap rock annually. Much of this material has been given to the counties as the State's contribution toward the improvement of the leading thoroughfares.

North Carolina, Delaware, Iowa, New Jersey, New York, Tennessee, and other States also have laws providing for the use of convict labor in improving the highways. North Carolina has made greater progress and has built more miles of roads under this system than any other State. Thus, one might, if space permitted, go through the whole list of States and find evidences of great progress in road improvement. Governor Mount, of Indiana, for instance, says that his Commonwealth is provided with 58,000 miles of graded, graveled, and piked highways, over 8,000 miles of which are comparable with the best roads of France. The public is now more thoroughly aroused to the importance of the movement for better roads than ever before, and more roads and better roads have been built in the United States in 1899 than in any previous year in its history.

The agitation which has become so universal will surely result in a well-defined public sentiment that will soon overcome all obstacles. With the new century, the good-roads movement is likely to receive valuable aid from the owners of horseless vehicles, already not uncommon on our thoroughfares. The aid of these new allies, added to that of the farmer, with his great pecuniary interest in the question, to say nothing of the army of wheelmen already enlisted in the cause, promises well for a rapid spread of the movement throughout the country.

DAIRY DEVELOPMENT IN THE UNITED STATES.

By Henry E. Alvord,
Chief of Dairy Division, Bureau of Animal Industry.

THE PRESENT FIELD OF THE DAIRY INDUSTRY.

No branch of agriculture in the United States has made greater progress than dairying during the nineteenth century. No other has received more direct benefit from the art of invention, the teachings of modern science, and the intelligent practice of skilled operators. Cooperative and commercial organizations have been formed to conduct the business locally and to guard its general interests. State laws and appropriations of money have been made to foster and promote this industry. Dairying has become the specialty of districts of wide area in different parts of the country. It is now regarded as among the most progressive and highly developed forms of farming in the United States.

The greater part of this country has been found so well adapted to dairying that its extension has more than kept pace with the opening and settlement of new territory. A belief was long entertained that successful dairying in America must be restricted to narrow geographical limits, constituting a "dairy belt" lying between the fortieth and forty-fifth parallels of latitude and extending from the Atlantic Ocean to the Missouri River; the true dairying districts were thought to be in separated sections, occupying not more than one-third of the area of this belt. These ideas have been exploded. It has been proved that good butter and cheese can be made, by proper management, in almost all parts of North America. Generally speaking, good butter can be made wherever good beef can be produced. Advantages unquestionably exist in the climate, soil, water, and herbage of certain sections, but these factors are largely under control, and what is lacking in natural conditions can be supplied by tact and skill. So that, while dairying is intensified, and constitutes the leading agricultural interest over large areas where the natural advantages are greatest, the industry is found well established in spots in almost all parts of the country and developing in unexpected places and under what might be considered as very unfavorable conditions.

DAIRYING DURING THE COLONIAL PERIOD AND AT THE PRESENT TIME.

Dairying was practiced in this country in colonial times, and butter and cheese are mentioned among the early exports from the settlements along the Atlantic coast; but this production was only a feature of general and pioneer farming. Dairying as a specialty did not appear in the United States to any extent until well along in the nineteenth century. The dairy history of the country is therefore identical with its progress in the present century. This progress has been truly remarkable. The wide territorial extension; the immense investment in lands, buildings, animals, and equipment; the great improvement in dairy cattle; the acquisition and diffusion of knowledge as to economy of production; the revolution in methods and systems of manufacture; the general advance in quality of products; the wonderful increase in quantity; the industrial and commercial importance of dairying, all constitute a prominent feature in the material progress of the nation.

DAIRYING DURING THE EARLY PART OF THE CENTURY.

During the early part of the century the keeping of cows on American farms was incident to the general work. The care of milk and the making of butter and cheese were in the hands of the women of the household, and the methods and utensils were crude. The average quality of the products was inferior. The supply of domestic markets was unorganized and irregular. The milch cows in use belonged to the mixed and indescribable race of "native" cattle, with occasionally a really good dairy animal appearing singly, almost by accident, or, at the best, as one of a family developed by some uncommonly discriminating yet unscientific breeder. The cows calved almost universally in the spring, and were generally allowed to go dry in the autumn or early winter. Winter dairying was practically unknown. As a rule, excepting the pasture season, cattle were insufficiently and unprofitably fed and poorly housed, if at all. It was a common thing for cows to die of starvation and exposure, and it was considered no disgrace to owners to have their cattle "on the lift"[1] in the spring. In the Eastern and Middle States the milk was usually set in small shallow earthen vessels or tin pans for the cream to rise. Little attention was paid to cooling the air in which it stood in summer or to moderating it in winter so long as freezing was prevented. The few who scalded fresh milk had no idea of the true reason for so doing or why beneficial effects resulted. The pans of milk oftener stood in pantries and cellars or on kitchen shelves than in rooms specially constructed or adapted to the purpose. In southern Pennsylvania and the States farther south spring houses were in vogue; milk received

[1] A common expression in years past in some localities, indicating the actual necessity of human aid to raise emaciated animals to their feet.

FIG. 1.—BUTTER MAKING—THE OLD WAY.

FIG. 2.—BUTTER MAKING—THE NEW WAY.

care, and setting it in earthen crocks or pots, standing in cool, flowing water, was a usual and excellent practice. Churning the entire milk was very common. This is still done to some extent in the Southern States, where butter is made every morning and where all the milk is buttermilk. In seasons of scarcity of milk there was no butter. In the Northern States there were some instances where families were supplied with butter weekly during most of the year, and with an occasional cheese, directly from the producers. But the general farm practice was to "pack" the butter in firkins, half firkins, tubs, and jars, and let the cheese accumulate on the farm, taking these products to market only once or twice a year. Not only were there as many different lots and kinds of butter and cheese as there were producing farms, but the product of a single farm varied in character and quality according to season and other circumstances. Every package had to be examined, graded, and sold upon its merits. It was usual for half the butter in market to be strong, if not actually rancid, and for cheese to be sharp. With the products largely low in grade, prices were also very low. (Pl. XVII.)

DAIRYING DURING THE MIDDLE OF THE CENTURY.

The above conditions continued without material change up to the middle of the century. Some improvement was noticeable in cattle and appliances, and in some sections dairy farming became a specialty, although not in a marked degree. Herkimer County, N. Y., is probably the best example of early dairy districts in this country. Of this county X. A. Willard wrote (in 1870) as follows:

> Cheese making began here more than sixty years ago. For upward of twenty years its progress was slow and the business was deemed hazardous by the majority of farmers, who believed that overproduction was to be the result of making a venture upon this specialty. The fact, however, gradually became apparent that the cheese makers were rapidly bettering their condition and outstripping in wealth those who were engaged in grain raising and a mixed husbandry. About the year 1830 dairying became general in the towns of Herkimer County north of the Mohawk, and some years later spread through the southern part of the county, gradually extending into Oneida and adjoining counties. Up to this period and for several years later little or no cheese was shipped to Europe. It was not considered fit for market till fall or winter. It was packed in rough casks and peddled in the home market at 5 to 8 cents a pound.

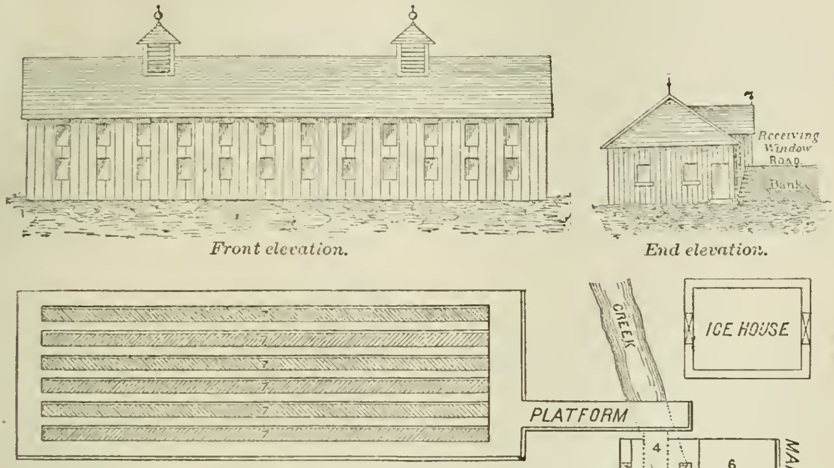
All the operations of the dairy continued rude and undeveloped even in these "dairying districts." The cows were milked in the open yard, and the curds were worked in homemade tubs and pressed in log presses. Everything was done by guess; there was no order, no system, no science in dairy operations. The cheese-making section gradually embraced the central and western portions of New York and the adjacent parts of Pennsylvania and Ohio, and the total production became large. Toward the middle of the century the gross supply of cheese was in excess of domestic demand, and cheese exports from the United States, mainly to Great Britain, ranged from 3,000,000 to 17,000,000 pounds a year. With the growth of cities and towns the business of milk supply increased and better methods prevailed. Yet, prior to the year 1850 no city had received any part of its milk supply by railroad transportation; near-by producers met all existing demands by hauling in their own vehicles. Butter making for home use and in a small way for local trade was common wherever cows were kept, and in some places there was a surplus sufficient to be sent to the large markets. Vermont and New York became particularly noted for butter production. "Franklin County butter," from counties of this name in those two States and in Massachusetts, was the favorite in New England markets, and the fame of "Orange County" and "Goshen" butter, from southern New York, was still more extensive.

DAIRYING DURING THE THIRD QUARTER OF THE CENTURY.

The twenty-five years following 1850 was a period of remarkable activity and progress in the dairy interests of the country. At first the agricultural exhibitions or "cattle shows," which were comparatively new and popular, and the enterprise of importers turned attention toward the improvement of farm animals; breeds of cattle noted particularly for dairy qualities were introduced and began to win the favor of dairy farmers. Then the early efforts at cooperation in dairying were recognized as successful, and were copied until the cheese factory became an established institution. Once fairly started in the heart of the cheese-making district of New York, the factory system spread with much rapidity. The "war period" lent additional impetus to the forward movement. The price of cheese, which was 10 cents per pound and less in 1860, rose to 15 cents in 1863 and to 20 cents and over in 1865. The foreign demand increased also, and the yearly cheese exports rose from 10,000,000 pounds in 1850 to 15,000,000 in 1860 and to almost 50,000,000 in 1865. Ten years later over 100,000,000 pounds were exported.

ESTABLISHMENT OF CHEESE AND BUTTER FACTORIES.

Although several earlier instances of associated dairying have been authenticated, which were locally successful, it is generally conceded that the credit of establishing the first real cheese factory, which served as a model and incentive to others (fig. 10), belongs to Jesse Williams, of Oneida County, N. Y. Mr. Williams lived upon his farm, near Rome. He was an experienced and skillful cheese maker, and his dairy had such a good reputation and its product was so eagerly sought at prices above the average that he increased his output of cheese by adding to his own supply of milk that from the herd of a son located upon a farm near by, and then from other neighbors. This idea of bringing together daily the milk from several neighboring farms, to be made into cheese at one place by a skilled operator, was



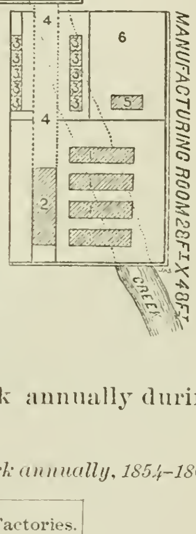


FIG. 10.—Elevations and plan of one of the first cheese factories built in the United States.

the germ from which sprang the cheese-factory system of the United States. Mr. Williams began working on this plan in 1851. He was so successful that a special building was erected the next year and fitted up with the best apparatus obtainable. The effect of this good example and the early extension of the factory system is shown by the following table, which gives the number of factories built and put into operation in New York annually during the years stated:

Number of cheese factories established in the State of New York annually, 1854–1866.

Year.	Factories.	Year.	Factories.
1854	4	1862	25
1855	2	1863	111
1856	3	1864	210
1857	3	1865	52
1858	4	1866	46
1859	4	Total in 1866	499
1860	17		
1861	18		

Cheese factories were soon started in Pennsylvania and Ohio, and then in other States, East and West. In 1869 the number in the whole country exceeded 1,000, and from that time the cooperative, or factory, system practically superseded the making of cheese on farms.

Making butter in quantity from milk or cream collected from numerous farms soon followed as the next advance in American dairying. Such establishments are properly butter factories, but the name of "creamery" has been generally adopted, and is not likely to be changed. The first creamery was built by Alanson Slaughter, near Wallkill, Orange County, N. Y., in the year 1861. The milk from 375 cows was received here daily. In Illinois the first cheese factory was started in 1863 and the first creamery in 1867. In Iowa these respective dates were 1866 and 1871. During the earlier years of their operation it was quite common for both butter and cheese to be made at the creameries at different times, or butter and skim cheese at the same time.

SOME FEATURES OF THE FACTORY SYSTEM OF DAIRYING.

The effect of the establishment of cheese and butter factories, comparatively new in kind, is to transfer the making of butter and cheese from the farm to the factory. Originating in this country, although now extensively adopted in others, the general plan may be rightly called "The American system of associated dairying." It constitutes one of the notable and important landmarks in the progress of dairying during the present century. The early cheese factories and creameries were purely cooperative concerns, and it is in this form that the system has usually extended into new territory, whether for the production of butter or cheese. The cow owners and producers of milk cooperate and share, upon any agreed basis, in organizing, building (or renting and refitting), equipping, and managing the factory and disposing of its products. The farmers interested as joint owners, and all who contribute milk or cream, are called the patrons. The operations are managed by a committee or board of directors chosen by and from the patrons. If the business is large enough to warrant the expense, the immediate supervision of the concern and all its interests is intrusted to a single manager, employed by the board. In a factory of this kind all expenses are deducted from the gross receipts from sales and the remainder is divided pro rata among the patrons upon the basis of the raw material contributed. Another plan is for the plant to be owned by a joint stock company, composed largely, if not wholly, of farmers, and milk or cream is received from any satisfactory producer. In this case interest on the property or capital is usually allowed and included in the current expenses. The management is otherwise the same; the stockholders receive a fixed rate of interest on their investment and the dividends to patrons depend upon their deliveries of milk or cream and the fluctuations of the market for the factory products. The proprietary plan is also common, being managed much like any other factory; the proprietor or company buys the milk or cream from the producers at prices mutually agreed upon from time to time and assumes all the expenses, risks, and returns of the business. Another way is for the factory, whether owned and managed by a company of farmers (probably themselves patrons) or by outsiders, to bear all expenses, make and sell the butter and cheese at a fixed charge per pound, and divide the net proceeds of sales as on the purely cooperative plan. All these plans are varied and modified in practice. Fig. 11 shows the ground plan of the first creamery in this country.

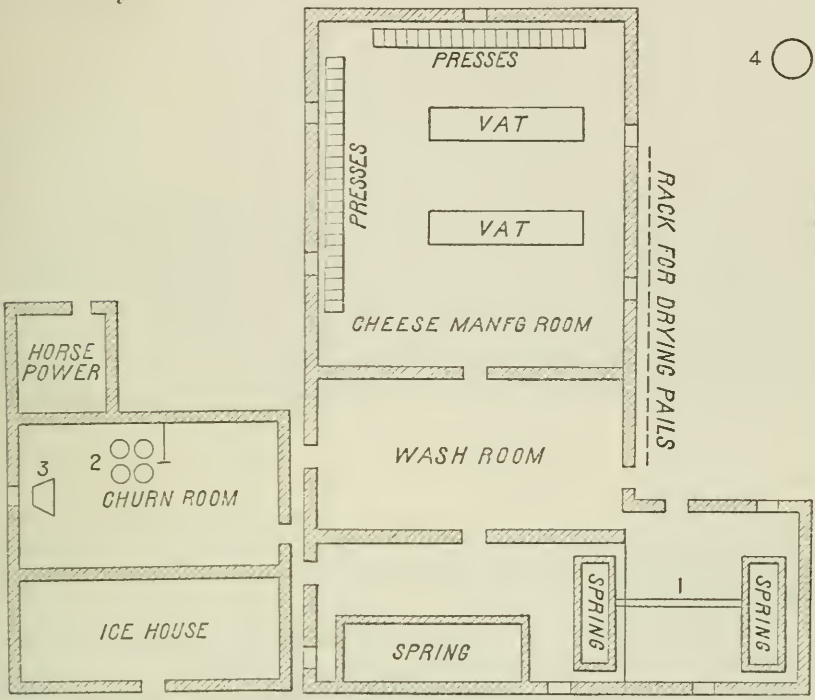


FIG. 11.—Ground plan of the first creamery, or butter factory, in the United States (provisions for cheese making, included): 1, water pipe; 2, churns; 3, butter worker; 4, whey cistern.

METHODS OF MANAGEMENT OF CHEESE AND BUTTER FACTORIES.

Independent of the matters of ownership, organization, and control, the factories and creameries differ much in methods of management and of settlement with patrons. Great progress in these particulars has been made since the introduction of the system. The first establishments received milk from patrons daily and sometimes twice a day. From near-by farms the milk was often warm from the cow at time of delivery. The milk was then kept in large vats (for cheese making) or in immense shallow pans in a cooling and creaming room until skimmed. Abundant room and expensive receptacles were necessary at the creamery. Then, for butter making, deep setting of the milk in cool water was adopted. The creameries were provided with pools or stationary vats below the floor level. Through these, cool water flowed from springs near at hand, and in them the milk was set in "shotgun" cans (fig. 12), immediately after arrival, for cooling and for cream to form. The pools were 18 or 20 inches deep, with racks at bottom to hold cans. The tin cans were 22 inches deep and 8 inches in diameter and filled so that when in the pool the top of the milk was just below the surface of the water. Springs with abundant flow and having a natural temperature of 48° to 56° F. were regarded as highly desirable. Afterwards came the method of mechanical cream separation (to be later described) in place of "setting," or the gravity system. Another radical change, which began about 1875, was to set and skim the milk on the farms and haul only cream to the factories. Agents from the creameries, with suitable teams and carrying cans, drove from farm to farm and gathered the cream. Hence, the name of "gathered-cream factories" for establishments of this class. This kind of factory is still the favorite in some good butter districts, and it has very decided merits. The earliest factories and creameries paid for milk by the quart or gallon and at the same price, all lots of equal bulk being regarded of equal value. The first step in advance on this line was to buy or credit milk by weight, but still all at the same price. On the gathered-cream plan, equal bulk measures of cream were long regarded as of like value, and this is still practiced to some extent. The most modern and approved plan is to pay for the milk or cream received by factory or creamery according to the pounds of fat it actually contains as experimentally determined. This will be referred to later. At first it was considered sufficient to have 200 cows tributary to a factory, and patrons were expected to be located within a mile or two, and 4 or 5 miles was the maximum haul. Larger factories were soon favored as more economical, and very large ones have been lately put in operation, each receiving the daily product of thousands of cows. Milk and cream is hauled twice as far as formerly to patronize a factory, and often by cooperation among the farmers along a "route." All patrons are now expected to cool their milk thoroughly before it leaves the farm. In the latest form of creamery management, cream is collected over many square miles of territory and transported long distances by rail to be made into butter at a central factory. (A modern creamery is shown in Pl. XVIII.)

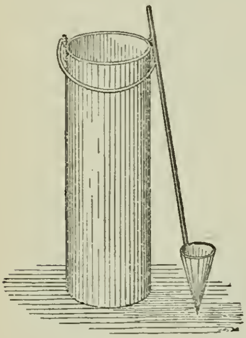


FIG. 12.—"Shot-gun" setting can and cream dipper.

THE CONDENSED-MILK INDUSTRY.

The condensed-milk industry had its beginning coincident with the inauguration of the factory system for making butter and cheese. Some method of preserving milk had long been sought and numerous preparations of the article had been offered, but these failed to meet the requirements and win public favor. In 1846 experiments were

FIG. 1.—A PIONEER CREAMERY IN THE STATE OF SOUTH DAKOTA.

FIG. 2.—A MODERN CREAMERY IN THE STATE OF NEW YORK.

begun in New York by Mr. Gail Borden with a view of securing a preserved milk that was pure, wholesome, and palatable, capable of being transported long distances and kept for long periods in trying climates, and then serving as a satisfactory substitute for crude, fresh milk; but it was not until 1856 that he obtained results which have since popularized the product in every quarter of the globe. The previously prevailing ideas of a dry form of milk (desiccated, solidified, or powdered) were abandoned, and it was decided that a semiliquid state was the best form for preservation. The correctness of this decision is attested by the fact that, extensive as the industry now is and numerous as are the commercial brands, all condensed milk is still prepared under substantially the system then originated. This applies to the unsweetened as well as to the sweetened article, for "plain condensed milk" was first introduced and put upon the market about the year 1861. It was then mainly in open vessels and intended for early use. At that time condensed milk in both forms had become well known, and four or five factories were in operation, each producing about 5,000 one-pound cans per day. For the year 1879 the production of condensed milk in the United States was reported as 13,000,000 pounds and for 1889 as 38,000,000 pounds.

APPLICATION OF MECHANICS TO THE DAIRY.

The third quarter of the century was also a period of unprecedented progress in the application of mechanics to the dairy. The factories

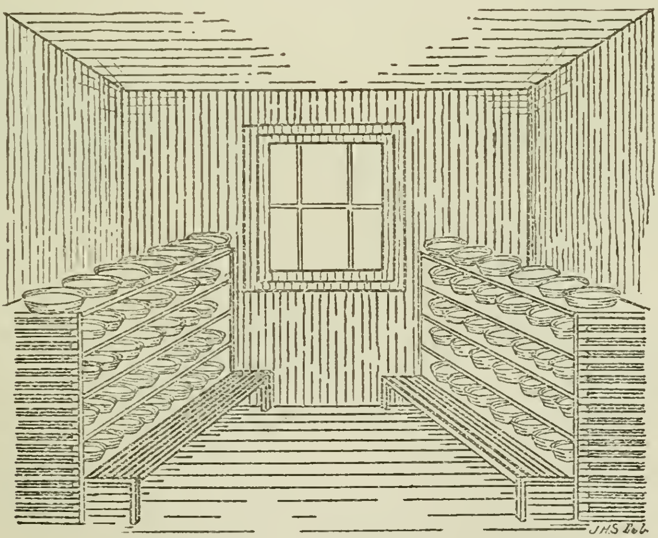


FIG. 13.—Milk room, with small shallow pans.

and creameries required new equipment, adapted to manufacture upon an enlarged scale, and equal attention was paid to the improvement of appliances for farm dairies. Shallow pans were changed in shape and greatly enlarged; some were made to hold 20 or 30 gallons, and had bottom and sides double for cooling or warming by the water jacket. (See figs. 13 and 14.) Then these big pans, and most others, disappeared in favor of deep setting. This system, in which deep

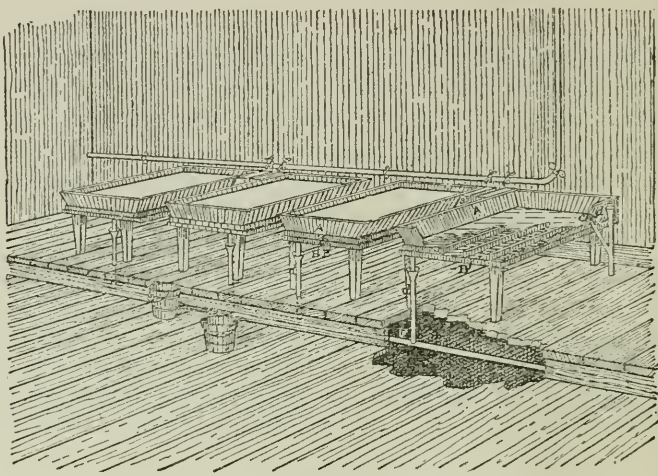


FIG. 14.—Large milk pans, open and shallow.

cans were used, set in cold water, preferably iced water, was introduced from Sweden, although the same principles had been in practice for generations in the spring houses of the South. Numerous creaming appliances, or creamers, were invented, based upon this

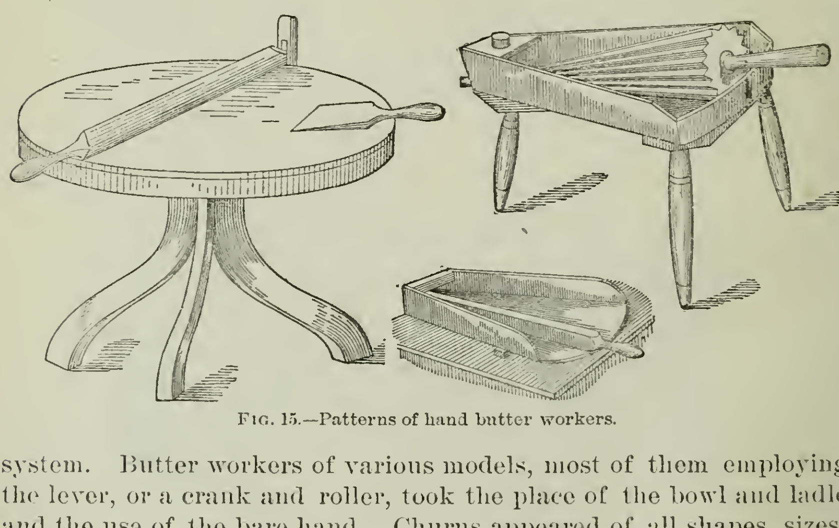


FIG. 15.—Patterns of hand butter workers.

system. Butter workers of various models, most of them employing the lever, or a crank and roller, took the place of the bowl and ladle and the use of the bare hand. Churns appeared of all shapes, sizes, and kinds, the general plan being to abolish dashers and substitute the agitation of cream for violent beating. About this time the writer made a search of the United States Patent Office records, which revealed the fact that forty or fifty new or improved churns were claimed annually, and, after about one-fourth were rejected, the patents actually issued provided a new churn every ten or twelve days for more than seventy years! This illustrates the activity of invention in the dairy line. It was admitted by all that at this period the United States was far in advance of any other country in the variety and excellence of its mechanical aids to dairying. (Fig. 15.)

ORGANIZATION OF DAIRYMEN'S ASSOCIATIONS.

The same period witnessed the organization of dairymen in voluntary associations for mutual benefit, the formation of clubs and societies of breeders of pure-bred cattle, and the appearance of the first American dairy literature of consequence in book form. The American Dairymen's Association was organized in 1863. Its field of activity was east of Indiana, and accordingly the Northwestern Dairymen's Association was formed in 1867. Both of these associations continued in existence, holding periodical conventions and publishing their proceedings for twelve or fifteen years. Then followed the formation of State dairy associations in Vermont (1870), Pennsylvania (1871), Wisconsin (1872), Illinois (1874), Iowa (1876), New York (1877), and other States, superseding the few pioneer societies, which, for the time, covered broader fields.

INTRODUCTION OF DAIRY CATTLE AND EFFORTS AT HERD IMPROVEMENT.

The Shorthorn breed led in the introduction of improved cattle to the United States, and for a long time the representatives of this race, imported from England, embraced fine dairy animals. Shorthorn grades formed the foundation, and an excellent one, upon which many dairy herds were built during the second and third quarters of the century, and much of this blood is still found in prosperous dairy districts. The period named was that of greatest activity in importing improved cattle from abroad; but Shorthorns have been so generally bred for beef qualities that the demand for them is almost exclusively on that line, and very few of the breed are now classed as dairy cattle. Ayrshires from Scotland, Holstein-Friesians from North Holland, and Jerseys and Guernseys from the Channel Islands, are the breeds recognized as of dairy excellence, and upon animals graded and improved from these the industry mainly depends. The first two breeds named are noted for giving large quantities of milk of medium quality; the other two, both often miscalled "Alderney," give milk of exceeding richness, and theirs is the favorite blood with butter makers. There are also the Brown Swiss and Simmenthal cattle from Switzerland, the Normandy breed from France, and Red-Polled cattle from the south of England which have dairy merit, but belong rather to what is called the "general-purpose" class. Associations of persons interested in maintaining the purity of the respective breeds have been formed since 1850, and they all record pedigrees and publish registers or herdbooks. Pure-bred herds of some of these different breeds are owned in nearly every State, and these animals aggregate 200,000 or 300,000. Their blood is so generally diffused that half-breeds or higher grades are very numerous wherever cows are kept for dairy purposes. Therefore, although pure-bred animals form less than 2 per cent of the working dairy herds, their influence is so great that it is probable the average dairy cow of the United States at the close of the century will carry nearly 50 per cent of improved blood. The breeding and quality of this average cow, and consequently her productiveness and profit, have thus been steadily advanced.

The progress made in this respect in fifty years has been remarkable. When improvement upon the native stock began, a cow that would make a pound of butter a day for two or three months was a local celebrity. Now and then a single animal made a really noteworthy record, like that of the Oakes cow, famous in Massachusetts about 1816. This cow gave 44 pounds of milk a day and made 467 pounds of butter during one season, but she was evidently a sport and failed to reproduce her equal. The first good record of definite herd improvement was made by Zadock Pratt, of Greene County, N. Y. By careful selection and culling he increased the average butter product of his 50 cows from 130 pounds for the year 1852 to 225 pounds in 1863; for seven years the average milk yield was 4,710 pounds per cow. About 1865, when good cows sold for $40 or less, an enterprising dairyman in New England advertised widely that he would pay $100 for any cow which would yield 50 pounds of milk a day on his farm for two or three consecutive days. Not an animal was offered under these conditions. The good dairy cow has now been so long bred to a special purpose that instead of the former short milking period, almost limited to the pasture season, it yields a comparatively even flow of milk during ten or eleven months in every twelve, and if desired the herd produces as much in winter as in summer. A cow that does not average 6 or 7 quarts of milk per day for three hundred days, being 4,000 to 4,500 pounds a year, is not considered profitable. There are many herds having an average yearly product of 5,000 pounds per cow, and single animals are numerous which give ten or twelve times their own weight in milk during a year. Quality has also been so improved that the milk of many a cow will make as much butter in a week as did that of three or four average cows of the mid-century. Whole herds average 300 to 350 pounds of butter a year, occasionally more, and authenticated records of cows giving 2 pounds a day are very numerous. Rivals to the Oakes cow may now be found frequently, often several in one bovine family, the dairy merit maintained and transmitted by judicious breeding; and although animals of such excellence are none too common, they no longer excite astonishment or incredulity. (Pl. XIX.)

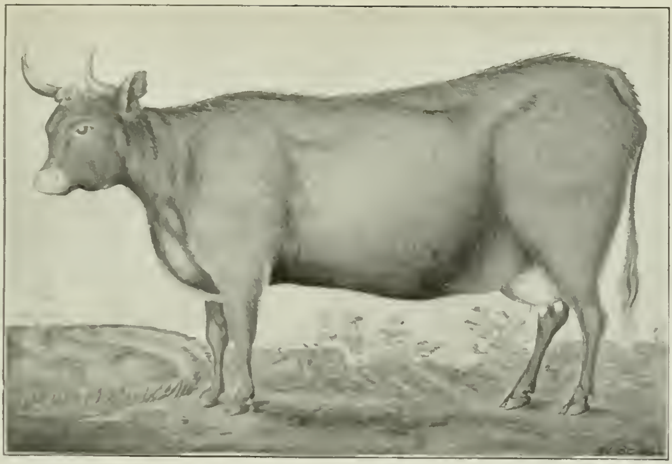


FIG. 1.—"THE OAKES COW."

FIG. 2.—DAIRY BULL, MODERN TYPE. GUERNSEY.

FIG. 3.—DAIRY COW, MODERN TYPE. JERSEY.

DAIRYING DURING THE CLOSING DECADES OF THE CENTURY.

The development of dairying in the United States during the closing decades of the nineteenth century has been uninterrupted and marked by events of the greatest consequence in its entire history. The importance of two inventions during this period can not be overestimated.

MECHANICAL SEPARATION OF CREAM FROM MILK.

The first is the application of centrifugal force to the separation of cream from milk. This is based upon the fact that the specific gravity of milk serum, or skim milk, is greater than that of the fatty portion, or cream. The dairy centrifuge, or cream separator (fig. 16), enables the creaming or "skimming" to be done immediately after milking, prefer-

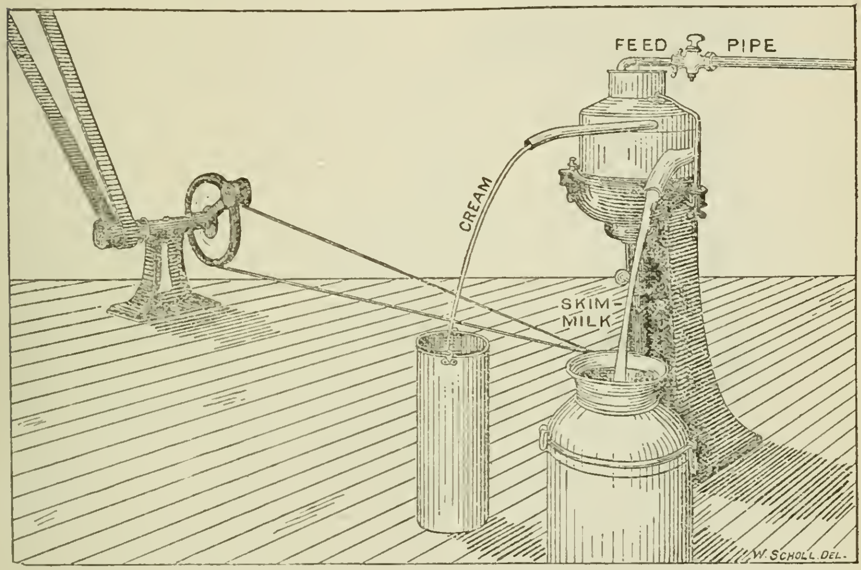


FIG. 16.—Centrifugal cream separator (in operation).

ably while the milk has its natural warmth. The cream can be churned at once, while sweet, but the better and usual practice is to cool thoroughly and then slowly cure, or "ripen," it for churning. The cream can be held at a comparatively high temperature, avoiding the necessity of much ice or cold water. The skim milk is available for use while still warm, quite sweet, and in its best condition for feeding to young animals. This mechanical method is more efficient than the old gravity system, securing more perfect separation and preventing loss of fat in the skim milk. It also largely reduces the dairy labor. The handling and care of the milk may be thus wholly removed from the duties of the household. Separators are made of sizes and patterns suited to farm use, and to be operated by hand or power—a dog or a sheep, a bull or a horse, water, electricity, or steam. The foregoing conditions apply when the separation is done on the farm where the milk is produced. In creamery practice the milk is usually aired and cooled on the patrons' farms and hauled once a day to the factory; there it is warmed to facilitate the work, passed through the separator, and the skim milk may be at once hauled back to the farms. A creamery uses one or more separators of large capacity, operated by power. This practice involves the double haul and an apparent waste of the farmer's time and labor. A movement toward economy in this respect is the establishment of "skimming stations" at convenient points, equipped with one or more power separators; to these the milk is taken for separation from the farms in the vicinity, and from these stations the cream is carried to the central factory for curing and churning.

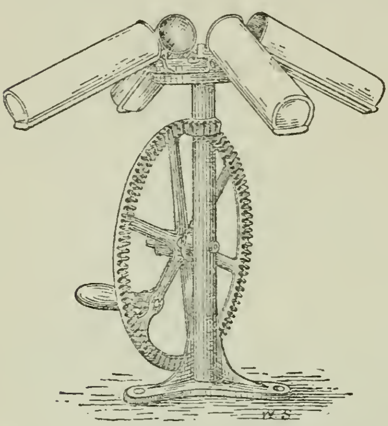


FIG. 17.—Babcock tester (cheap form, without bottles).

Besides its economy and its effect upon labor, the mechanical cream separator almost eliminates the factor of climate in a large part of dairy management, and altogether has worked a revolution in the industry. The centrifuge is still a marvel to those who see it working for the first time. The whole milk, naturally warm or warmed artificially, flows into a strong steel bowl held in an iron frame; the bowl revolves at rates varying from 1,500 to 25,000 times per minute, and from two projecting tubes the cream and skim milk separately flow in continuous streams. The machines can be regulated to produce cream of any desired quality or thickness. These separators of different sizes are capable of thus skimming or separating (more properly, creaming) from 15 to 500 gallons of milk per hour. A machine of standard factory size has a speed of 6,000 to 7,000 revolutions a minute and a capacity for creaming 250 gallons of milk an hour.

The world is indebted to Europe for this invention, at least as a dairy appliance. It is the only instance in which dairy invention abroad has been notably in advance of the United States. Yet, investigations were in progress contemporaneously in this country along the same line, and many of the material improvements in the cream separator and several novel patterns have since been invented here. The machine has been vastly improved during its twenty years of existence. At first the bowl was filled with a "charge" of milk, the separation effected, the machine stopped, its compartments emptied of milk and cream, then refilled and started again. The continuously acting machine was soon invented, however, and is now universal.

Most of the power machines are still operated by pulley, belting, and intermediate (as shown in fig. 16), but in the latest patterns steam is applied directly to a turbine wheel in the base of the standard. The first centrifugal separators were put into practical use in this country and Great Britain in the year 1879. On the continent of Europe they were used a little earlier. The century closes with more than 40,000 of these machines in operation in the United States.

FAT TEST FOR MILK.

The second great dairy invention of the period is the popular fat test for milk, being a quick and easy substitute for chemical analysis. This is one of the public benefactions of the agricultural experiment stations. In several States these stations have done much creditable

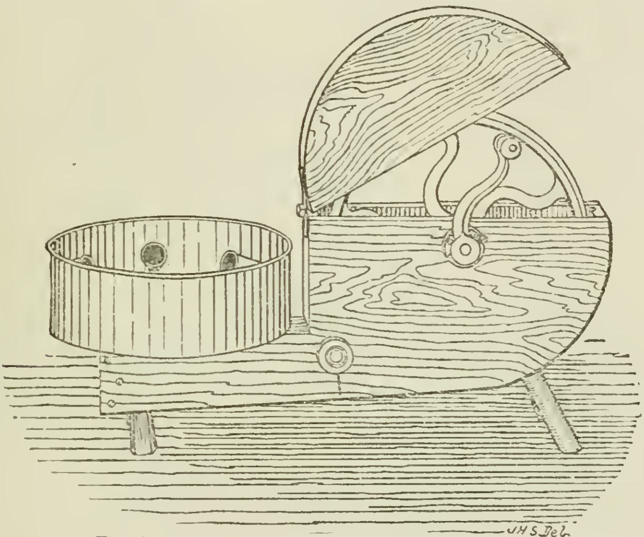


Fig. 18.—Early and cheap form of Babcock tester.

work in dairy investigation, and from them have come several clever methods for testing the fat content of milk. The one which has been generally approved and adopted in this and other lands is named for its originator, Dr. S. M. Babcock, chemist and dairy investigator, first of the New York experiment station at Geneva and since of the Wisconsin experiment station. (See figs. 17 to 21.) This test combines the principle of centrifugal force with simple chemical action. The machine on the Babcock plan has been made in a great variety of patterns, simple and inexpensive for home use and more elaborate and substantial for factories. By these machines from two to forty samples may be tested at once in a few moments, and by the use of bottles specially provided the percentage of fat may be determined in samples of milk, cream, skim milk, or buttermilk. Of course, the glassware appurtenances of these testers must be mathematically accurate. Besides the machine and its fittings, the only supplies needed are sulphuric acid of standard strength and warm water. Any person of intelligence can soon learn to make ordinary tests with this appliance, but care and skill are necessary to absolutely correct results.

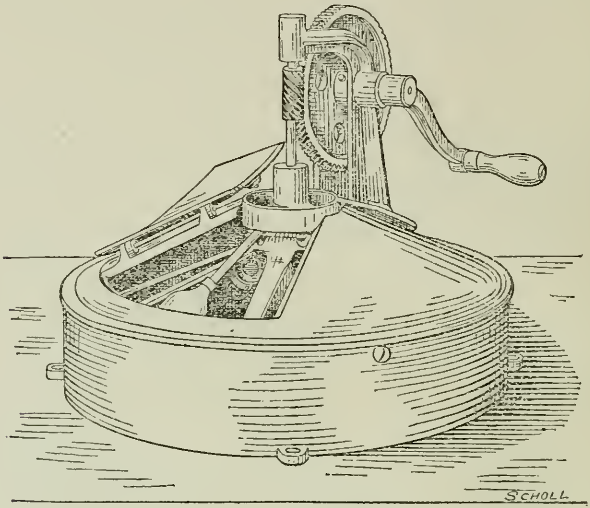


FIG. 19.—Hand Babcock tester, with strong drum.

This fat test of milk has wide application, and it may fairly be questioned whether it is second to the cream separator in advancing the economics of dairying. The percentage of fat being accepted as the measure of value for milk for nearly all purposes, the Babcock

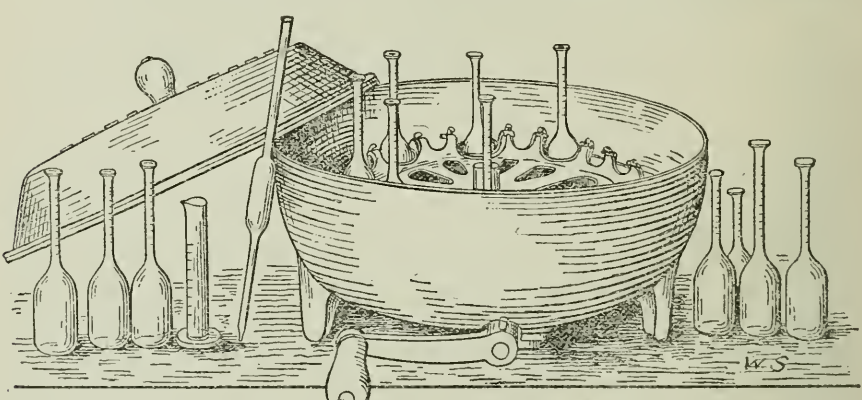


FIG. 20.—Hand Babcock tester, with variety of glassware.

test may be the basis for municipal milk inspection, for fixing the price of milk delivered to city dealers, to cheese factories, creameries, and condenseries, and for commercial settlements between patrons in cooperative dairying of any kind. By this test also the dairy farmer may prove the quality of milk from his different cows and (with quantity of milk yield recorded) may fix their respective value as dairy animals. Cows are now frequently bought and sold upon the basis of the milk scale and the Babcock test. With perfect apparatus in competent hands the accuracy of the test is beyond question, and it is of the highest scientific value and practical use. It should be noted that although clearly patentable, thus offering to the patentee an independent income through a very small royalty, this priceless invention and boon to dairying was freely given to the public by Dr. Babcock. Recognition of this public service has taken the form of a medal voted by the legislature of Wisconsin, and a handsome testimonial has been sent by the spontaneous action of appreciative creamerymen in distant New Zealand.

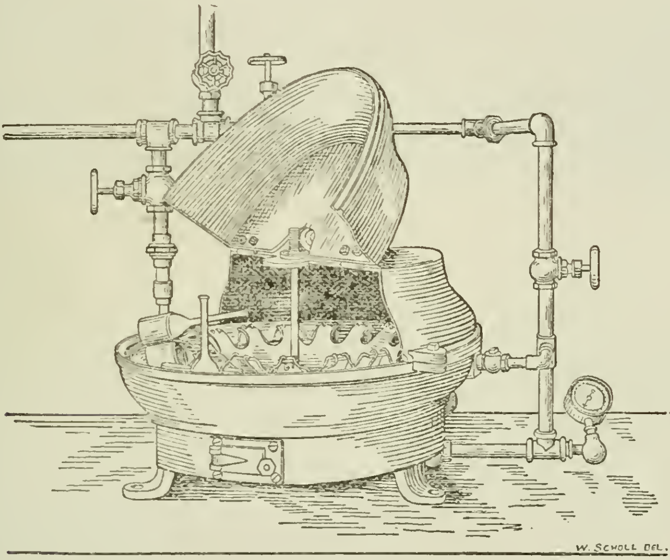


FIG. 21.—Babcock tester for use by direct steam power, or "turbine tester."

DAIRYING AT THE PRESENT TIME.

The advent of the twentieth century will find the dairy industry of the United States established upon a plane far above the crude and variable domestic art of three or four generations ago. The milch cow itself, upon which the whole business rests, is almost as much a machine as a natural product, and, as already shown, a very different creature from the average animal of the olden time. Instead of a few homely and inconvenient implements for use in the laborious duties of the dairy, perfected appliances, skillfully devised to accomplish their object and lighten labor, are provided all along the way. Long rows of shining tin pans no longer adorn rural dooryards. The factory system of cooperative or concentrated manufacture has so far taken the place of home dairying that in entire States the cheese vat or press is as rare as the handloom, and in many counties it is as hard to find a farm churn as a spinning wheel.

A SAMPLE OF THE CHANGES IN DAIRY PRACTICES.

Here is an example of the radical change wrought in dairy practices: Northern Vermont has long been a region of large butter production. St. Albans is the business center of Franklin County. During the middle of the century the country-made butter from miles around came to this market every Tuesday. The average weekly supply was 30 to 40 tons. This butter was very varied in quality, was sampled and classified with much labor and expense, placed in three grades, and forwarded to the Boston market, 200 miles distant. During twenty-five years ending in 1875, some 65,000,000 pounds, valued at $20,000,000, passed through this little town. All of this was dairy butter made upon one or two thousand different farms, in as many churns. In 1880 the first creamery was built in this county; ten years later there were fifteen. Now, a creamery company located at St. Albans has fifty-odd skimming or separating stations distributed through this and adjoining counties. (Pl. XX.) To those is carried the milk from more than 30,000 cows. Farmers having home separators may deliver cream which, being inspected and tested, is accepted and credited at its actual butter value, just as other raw material is sold to mills and factories. The separated cream is conveyed by rail and wagon—largely the former—to the central factory. There, in one room, from 10 to 12 tons of butter are made every working-day. A single churning place for a whole county! All of this butter is of standard quality, "extra creamery," and is sold on its reputation, upon orders from different points received in advance of its manufacture. The price is relatively higher than the average for the product of the same farms fifty years ago. This is mainly because of better average quality and greater uniformity—two important advantages of the creamery system.

METHOD OF MILKING UNCHANGED.

In one respect dairy labor is the same as a hundred years ago. Cows still have to be milked by hand. Although numerous attempts have been made, and patent after patent has been issued, no mechanical contrivance has yet been a practical success as a substitute for the human hand in milking. Therefore, twice a day, every day in the year, the dairy cows must be milked by manual labor. This is one of the main items of labor in dairying, as well as a most delicate and important duty. Allowing 10 cows per hour to a milker, which means lively work, it requires the continuous service of an army of 300,000 men, working ten or twelve hours a day throughout the year, to milk the cows kept in the United States.

FIG. 1.—SKIMMING STATION OF A VERMONT CREAMERY.

FIG. 2.—FRANKLIN COUNTY CREAMERY, ST. ALBANS, VT.

FIG. 1.—EXHIBIT OF FOREIGN BUTTERS BY THE UNITED STATES DEPARTMENT OF AGRICULTURE, 1899.

FIG. 2.—NATIONAL CREAMERY BUTTER MAKERS' ANNUAL COMPETITION, SIOUX FALLS, S. DAK., JANUARY, 1899.

FIG. 1.—IOWA DAIRY SCHOOL AND COLLEGE CREAMERY AT AMES.

FIG. 2.—WISCONSIN DAIRY SCHOOL AT MADISON—MILK TESTING.

ORGANIZATION OF THE DAIRY INDUSTRY.

The industry is becoming thoroughly organized. Besides local clubs, societies, and unions, there are dairy associations in thirty States, most of them incorporated, and receiving financial aid under State laws. The proceedings of the annual conventions are, in several instances, reported and published at public expense. In some States the butter makers and cheese makers are separately organized; in some States creamery men and dairy farmers hold separate meetings. Large competitive exhibits of dairy products are also held, and Pl. XXI shows the annual exhibit for 1899 of the National Creamery Butter Makers at Sioux Falls, S. Dak., including the exhibit of foreign butters by the Department of Agriculture. Eighteen States provide by law for officials known as dairy commissioners or food and dairy commissioners. These officers have a national association, and there are also two national organizations of dairymen. At several large cities and centers of activity in the commerce of the dairy there are special boards of trade. The Department of Agriculture has a Dairy Division, whose purpose is to keep informed upon and to promote the dairy interests of the country at large. Dairy schools are maintained in a number of States, offering special courses of practical and scientific instruction in all branches of the business. (Pl. XXII.) These schools and the agricultural experiment stations, with which most of the dairy schools are connected, are doing much original research, and constantly adding to the store of useful information as to the application of modern science to this industry. Graduates from the schools are scattered all over the country as managers of dairy farms and superintendents of creameries and cheese factories, and are contributing to the general improvement in dairy methods and results. Weekly and monthly journals in the interest of dairy production and trade are published in various parts of the country, and during the last decade or two a number of noteworthy books on different aspects of dairying have been published, so that the student of this subject may fill a good-sized case with substantial volumes, technical and practical in character.

MILK PRODUCTION.

The business of producing milk for town and city supply, with the accompanying agencies for transportation and distribution, has grown to immense proportions. In many places the milk trade is regulated and supervised by excellent municipal ordinances, which have done much to prevent adulteration and improve the average quality of the supply. Full as much, however, is being done by private enterprise, through large milk companies, well organized and equipped, and establishments which make a specialty of serving milk and cream of fixed quality and exceptional purity. These efforts to furnish "certified" and "guaranteed" milk and general competition for the best class of trade are doing more to raise the standard of quality and improve the service than all the legal measures. The buildings and equipment of some of these modern dairies are quite beyond precedent. This branch of dairying is advancing fast, and upon the substantial basis of care, cleanliness, and better sanitary conditions. (Pls. XXIII and XXIV.)

CHEESE MAKING.

Cheese making has been transferred bodily from the realm of domestic arts to that of manufactures. Farm-made cheeses are hard to find anywhere; they are used only locally, and make no impression upon the markets. In the middle of the century about 100,000,000 pounds of cheese was made yearly in the United States, and all of it in farm dairies. At the close of the century the annual production of the country will be about 300,000,000 pounds, and 96 or 97 per cent of this will be made in factories. Of these establishments, there are nearly 3,000, but they vary greatly in capacity, and many are very small. New York and Wisconsin each has a thousand. The former State makes nearly twice as much cheese as the latter, and the two together produce three-fourths of the entire output of the country. The other cheese-making States, in the order of quantity produced, are Ohio, Illinois, Michigan, and Pennsylvania; but these are all comparatively unimportant. A change observed as taking place in the factory system is that of bringing a number of factories previously independent into a "combination" or under the same management. This tends to improve the quality and secure greater uniformity in the product, and often reduces cost of manufacture, all being decided advantages. More than nine-tenths of all cheese made is of the familiar standard variety, copied after the English Cheddar, but new kinds and imitations of foreign varieties are increasing. The cheese made in the country, with the small importations added, gives a yearly allowance of less than 4 pounds to every person; but as 30,000,000 to 50,000,000 pounds are still annually exported, the per capita consumption of cheese in the United States does not exceed 3½ pounds per annum. This is a very low rate, much less than in most European countries.

BUTTER MAKING.

Great as the growth of the associated system of butter making has been and fast as creameries have multiplied, especially in the newer and growing agricultural States, such as Minnesota, Nebraska, Kansas, South Dakota, and Washington, there is still much more butter made on farms in the United States than in creameries. Creamery butter controls all the large markets, the dairy products making comparatively little impression on the trade; but home consumption and the supply of small customers and local markets make an immense aggregate, being fully two-thirds of all. Estimating the annual

FIG. 1.—DAIRY BARN FOR 250 COWS IN NEW JERSEY.

FIG. 2.—MILKERS READY FOR WORK AT LARGE DAIRY FARM IN NEW JERSEY.

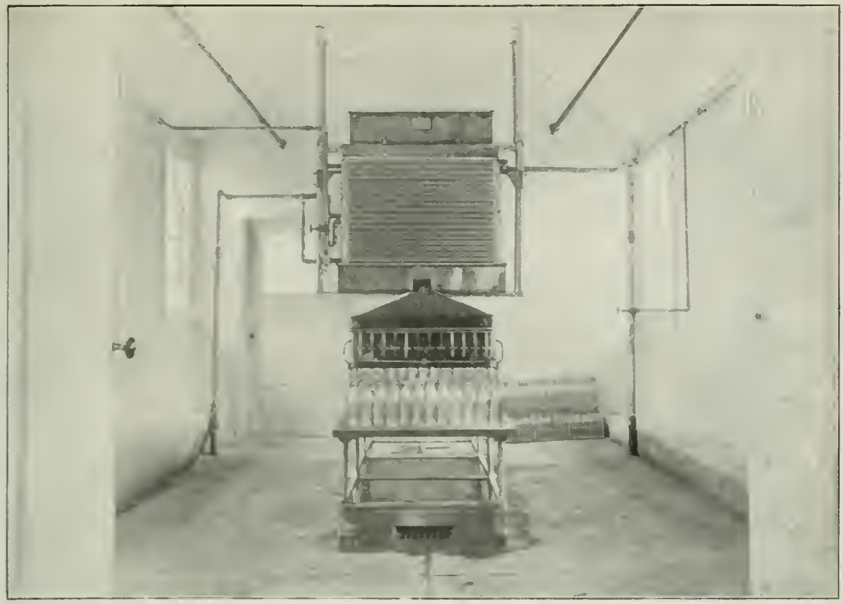


FIG. 1.—COOLING AND BOTTLING ROOM ON A DAIRY FARM IN PENNSYLVANIA.

FIG. 2.—BOTTLING ROOM ON A DAIRY FARM IN NEW YORK.

butter product of the country at 1,400,000,000 pounds, not much over 400,000,000 of this is made in the 7,500 or 8,000 creameries now in operation. Iowa is the greatest butter-producing State and the one in which the greater proportion is made on the factory plan. This State has 780 creameries, only two counties being without them; about two-fifths are cooperative. In these creameries about 88,000,000 pounds of butter are yearly made from 624,000 cows. It is estimated that in the same State 50,000,000 pounds of butter in addition are made in farm dairies. The total butter product of this State is therefore one-tenth of all made in the Union. Iowa sends over 80,000,000 pounds of butter every year into other States. New York is next in importance as a butter-making State, and then come, in order, Pennsylvania, Illinois, Wisconsin, Minnesota, Ohio, and Kansas. Yet, all of these combined make but little more than one-half of the annual butter crop of the United States, and in no one of them except Iowa is half of the butter produced made in creameries. The average quality of butter in America has materially improved since the introduction of the creamery system and the use of modern appliances, and the average continues to improve. Nevertheless, a vast quantity of poor butter is made—enough to make a large and profitable business in collecting it at country stores at grease prices or a little better and rendering or renovating it by patent processes. This renovated butter has been fraudulently sold to a considerable extent as the true creamery article, of which it is a fair imitation while fresh, and several States have recently made laws to identify the product and prevent buyers from being deceived. No butter is imported into this country, and the quantity exported is as yet insignificant, although there is beginning to be a foreign demand for American butter. The home consumption must accordingly be at the yearly rate of 20 pounds to the person, or about 100 pounds annually to the family of average size. If approximately correct, this shows Americans to be the greatest butter-eating people in the world.

The people of this country also consume millions of pounds every year of butter substitutes and imitations, such as oleomargarine and butterine. Most of this is believed to be butter by those who use it, and the State dairy commissioners mentioned are largely occupied in the execution of laws intended to protect consumers from these butter frauds.

BY-PRODUCTS OF DAIRYING.

Within recent years there has been great development in the economical uses of the by-products of dairying. Ten years ago there were enormous quantities of skim milk and buttermilk from the creameries and of whey from cheese factories, which were absolutely wasted. At farm dairies these by-products are generally used to advantage in feeding animals, but at the factories, especially at the seasons of greatest milk supply, this most desirable method of utilization is largely impracticable. In many places new branches have lately been added to the industry, which make sugar of milk and some other commercial products from whey, and utilize skim milk in various ways. The albumen of the latter is extracted for use with food products and in the arts. The casein is desiccated and prepared as a baking supply and substitute for eggs, as the basis of an enamel paint, as a substitute for glue in paper sizing, and it is also solidified so as to make excellent buttons, combs, brush backs, handles, electrical insulators, and similar articles.

NUMBER OF COWS AND QUANTITY AND VALUE OF DAIRY PRODUCTS.

The cows in the United States were not counted until 1840, but have been since enumerated for every decennial census. It has required from 23 to 27 cows to every 100 of the population to keep the country supplied with milk, butter, and cheese, and provide for the export of dairy products. The export trade has fluctuated much, but has never exceeded the produce of 500,000 cows. With the closing years of the century it is estimated that there is one milch cow in the United States for every four persons. This makes the total number of cows about 17,500,000. They are unevenly distributed over the country, being largely concentrated in the great dairy States. Thus, Iowa leads with 1,500,000 cows, followed by New York with almost as many; then Illinois and Pennsylvania, with about 1,000,000 each. The States having over 500,000 each are Wisconsin, Ohio, Kansas, Missouri, Minnesota, Nebraska, and Indiana. Texas is credited with 700,000 cows, but very few of them are dairy animals. In the Middle and Eastern States the milk product goes very largely to the supply of the numerous large towns and cities. In the Central West and Northwest butter is the principal dairy product. The following table gives approximately an exhibit of the quantity and value of the dairy products of the United States in the year 1899:

Estimated number of cows and quantity and value of dairy products.

Cows.	Product.	Rate of product per cow.	Total product.	Rate of value.	Total value.
				Cents.	
11,000,000	Butter	130 pounds	1,430,000,000 pounds	18	$257,400,000
1,000,000	Cheese	300 pounds	300,000,000 pounds	9	27,000,000
5,500,000	Milk	380 gallons	2,090,000,000 gallons	8	167,200,000

This gives the grand total of the dairy products of the country a value of $451,600,000. If to this be added the skim milk, buttermilk, and whey, at their proper feeding value, and the calves dropped yearly, the annual aggregate value of the produce of the dairy cows exceeds $500,000,000. Accepting these estimates as conservative, they show that the commercial importance of the dairying of the United States is such as to command attention and justify all reasonable provisions for guarding its interests.

DEVELOPMENT OF THE NUTRITION INVESTIGATIONS OF THE DEPARTMENT OF AGRICULTURE.

By A. C. True, Ph. D., *Director*, and R. D. Milner, Ph. B., *Assistant in Nutrition Investigations, Office of Experiment Stations.*

INTRODUCTION.

The subject of food economy in all its details, always of vital interest, has acquired increased importance in this country in recent years from the extensive investigations that have been made and are still being prosecuted in connection with and as a part of the work of the Department of Agriculture and the agricultural experiment stations. There had been a considerable amount of investigation of the food of man, as well as studies of the food of domestic animals, before the stations were established. Much of the early experimenting was carried on in connection with physiological investigations or other work connected with the study of medicine. Some of the investigations, however, are directly comparable with more recent work.

The first American investigation on the subject of human nutrition which has been found by the authors was prosecuted by J. R. Young in Philadelphia in 1803. It was entitled "Experimental inquiry into the principles of nutrition and the digestive process." The author studied the nutritive value and digestibility of such materials as sugar, gum, beans, and wheat, making experiments with frogs and other small animals. The article summarizes the ideas on human nutrition held at that time.

With the rise of the experiment stations inquiries into the composition of feeding stuffs and their appropriate use in the nutrition of domestic animals were undertaken, and have since been carried on quite actively. Later some of the stations undertook similar investigations of the food and nutrition of man. The science of the nutrition of man has so much in common with that of nutrition of animals that a distinction between the two is not easily made, and naturally they have been studied together. These researches have been carried on mainly in the physiological and chemical laboratories of universities as well as of experiment stations. On the whole, for the study of foods and the laws of nutrition, much more experimental inquiry has been made with animals than with men, partly because of the greater ease and convenience of experimenting with animals and partly because of the especial activity of the experiment stations in this direction. The attention devoted to the special study of feeding stuffs for animals, up to the present time, is likewise greater than that devoted to the special study of the food of man, leaving out of account, of course, the subject of food adulteration, which comprises a phase of the general investigations not discussed here.

The growth and development of this subject in the United States has an interesting history. Beginnings were made by physicians and other scientific investigators. Much of the work with which the nutrition investigations of this Department are directly connected and out of which they grew was of this nature, and not a little was made possible only by the generosity of private individuals; then economic institutions and Government scientific departments became interested, and finally the results of the work proved so valuable and useful that Congress made special appropriation for carrying on investigations in nutrition in different places throughout the country.

SCOPE OF INVESTIGATIONS ON THE FOOD AND NUTRITION OF MAN.

Investigations on the food and nutrition of man include the study of two branches of the subject, which, though quite intimately related and both valuable, are nevertheless of importance in different ways. One branch of the subject comprises a study of the chemical composition of different food materials, an investigation that is purely analytical, but a necessary preliminary to the investigation in the other branch of the subject, which comprises researches into the laws of nutrition and the economic and sociological application of the subject. The former has to do with simply the chemistry of food, while the latter has to do with the physiology—the physics and chemistry—of the nutrition of man, together with its economic and sociological application to people of different classes in different places and under different conditions.

From the first many investigations have been made which studied food incidentally in connection with some special problem—for instance, the effect of some drug. Mention should be made in this connection of the experiments of Professor Chittenden, of Yale University, on this and similar lines. This work is still carried on; the earliest results were published, however, some twenty years ago.

Some very interesting experiments have been made by earlier American investigators on the effect of muscular exertion on the production of urea. One of the most noteworthy investigations of this nature was made by Dr. Flint in 1871 with the professional pedestrian Weston. The earliest study of dietaries which the authors have found was made by J. S. Gould, published in 1852, entitled "Report on the food and diet suited for almshouses, prisons, and hospitals." These are only a few of the investigations which might be cited.

A considerable part of the early work in the study of foods in this country was analytical, along the line of the chemical composition of different food materials. A not inconsiderable amount of such work was done between the years 1840 and 1860, most of which, however, is of interest to-day chiefly from a historical standpoint. The greatest accuracy of the work done at that time was in the determination of the elementary composition and the inorganic compounds of the food products. A considerable number of analyses were carefully made in an attempt to learn the proximate composition also; but accurate and reliable methods of organic and analytical chemistry had not yet been fully developed, so the results are comparable only in a general way with those of analyses which have been made according to the so-called "Weende" methods, which were devised and came into general use about 1864. Since that time it has been possible to carry on systematic investigations of food materials from the standpoint of their nutritive values as determined by their chemical composition.

A considerable amount of investigation of materials used as food by man has been for many years and is still being carried on by the Division of Chemistry of the Department of Agriculture. Mr. Clifford Richardson made a large number of analyses of specimens of American flour and the bread made from them, and of fresh vegetables and other materials. Prof. H. W. Wiley, the present chief of the Division, and his associates, have also made a great many analyses of cereal grains and their products, canned foods, meats, and other materials. A great deal of study of the composition of food materials has been made by Professor Wiley in the prosecution of his investigations of adulteration of foods. A considerable number of analyses of foods, especially dairy products, sugars, fruits, and vegetables, were made elsewhere in this country prior to the establishment of the experiment stations. This work has been continued and materially extended by the stations.

INCEPTION OF THE PRESENT COOPERATIVE INQUIRIES ON THE NUTRITION OF MAN.

The particular inquiry on the nutrition of man, which has developed into the cooperative inquiries now being prosecuted in different parts of the country under the auspices of the Department of Agriculture, had its inception in the study of the chemical composition and nutritive economy of food fishes and invertebrates that was undertaken by Prof. W. O. Atwater in 1877, in the chemical laboratory of Wesleyan University, at the instance of Prof. S. F. Baird, Secretary of the Smithsonian Institution and United States Commissioner of Fish and Fisheries.

The investigations, begun then and continued until 1882, included (1) chemical analyses of fishes and invertebrates; (2) experiments upon the digestibility of fish; and, (3) studies of the chemical constitution of the flesh of fish. In the course of these investigations there were studied some two hundred specimens of marine and fresh-water fishes and invertebrates commonly used for food in the United States. For the prosecution of this inquiry small sums were appropriated from time to time, through the agency of Professor Baird, to defray the expense for apparatus and labor of assistants. Several citizens of Middletown, Conn., of New York, and of other places, feeling personally interested in and recognizing the need of just such work, contributed generously toward carrying out investigations much more elaborate and extensive than would have been possible without such material assistance. Doubtless from the interest of those individuals, manifested in such a manner, the work was given at once an importance which otherwise it might have been long in acquiring. The information regarding the food value of fish that was obtained through these studies emphasized the need of similar study of other food materials.

In 1884 Professor Atwater was asked to prepare plans for specimens, labels, and other illustrative materials for the food collection of the United States National Museum. In the development of these plans it appeared very desirable to illustrate the fundamental principles of food economy, for which purpose there was need of considerable information concerning the chemical composition of some of the more common food materials in use in this country. This information was not then available, because no extensive investigations of American food products had ever been made. To make such investigations was a large undertaking, and the necessity for doing so was not popularly understood. A beginning was made, however, with the hope that as the results of the work should appear and their value should be realized the means for continuing the inquiry would be found. By 1888 nearly one hundred specimens of food products, mostly animal, but including some vegetable, had been analyzed in the laboratory of Wesleyan University, the expense of the work being met in part by the National Museum and in part by contributions from private sources. In 1888 the Storrs experiment station was established and placed under the direction of Professor Atwater. Provision was made for conducting its chemical investigations in the Wesleyan University laboratory, and the analysis of animal and vegetable food products was continued as part of its work, both as independent inquiries and in connection with dietary studies and other investigations, which will be mentioned later.

The World's Columbian Exposition, in 1893, afforded a most favorable opportunity for collecting specimens of food materials of particular interest in the United States. On behalf of the executive committee on awards for that exposition, Prof. H. W. Wiley, of the Department of Agriculture, undertook the investigation and analysis of a large number of specimens of cereal grains and milling products from them, sugars, and other products. These investigations were carried on at the exposition and were completed later in the laboratory at Washington City. On behalf of the same committee, Professor Atwater undertook similar investigations of prepared foods, and especially animal foods. Over six hundred specimens of such foods were collected for this investigation. The work was carried on so far as possible at Chicago during the exposition. Afterwards it was transferred to Middletown, Conn., and was continued in the laboratory of Wesleyan University as part of the work of the Storrs station. Analyses of over five hundred specimens were completed by 1894. This was the most extensive investigation of this character undertaken up to that time in this country. In this work, as well as in other nutrition investigations, Prof. C. D. Woods has been prominently associated with Professor Atwater.

STUDY OF DIETARIES.

Meanwhile the investigations in nutrition had been begun along another line, namely, the study of dietaries, in an attempt to learn something concerning the character and quantity of food actually consumed by people in different circumstances of life in different localities. The first extensive work of this kind in this country carried on by the methods followed at the present time was undertaken by Hon. Carroll D. Wright, in 1886, while chief of the Massachusetts bureau of statistics of labor. For the purpose of supplying, in some measure, information necessary to enable the workingman to regulate more intelligently his expenditures for food and to secure with a given expenditure the maximum amount of nutritive ingredients, the bureau collected a number of schedules of dietaries, giving quantities and cost of food used by working people in different cities in Massachusetts and also in some localities in Canada, from which some of the working people had come. The data thus collected were submitted to Professor Atwater, under whose supervision the quantities of nutritive ingredients in the food purchased were estimated. The statistics of quantities of food purchased were compiled from original accounts with tradesmen. No analysis of foods was made in these studies. The amounts of ingredients contained in the food were estimated upon the basis of the results of analyses of similar foods already made. So far as possible, American analyses were used; for the materials of which no analyses had been made in this country, however, the results of European analyses were employed.

The results of these studies were only approximately correct. In order to secure more reliable data, which might be useful in estimating dietary standards and in more accurate inquiry in food economy, similar studies were carried on at Middletown, Conn., under the direction of Professor Atwater. In these studies the errors in collecting data observed in the preceding studies were eliminated so far as possible, and analyses of many of the foods used were actually made.

The classes of people studied included not only laborers' families, but also students' boarding clubs and well-to-do persons. The results of these studies, together with those of the former studies, seemed to warrant generalizations of considerable interest, and particularly to indicate the directions in which further inquiry was needed. The work thus done represented the beginning of an investigation of an important subject. In 1890 the Storrs experiment station, in cooperation with the United States Department of Labor, which had been established with Hon. Carroll D. Wright as Commissioner, undertook a series of accurate dietary studies, which were continued for several years. By January, 1895, twenty-one such studies of the actual food consumption of families of mechanics and professional men had been made and reported by the station. Similar investigations have since been carried on elsewhere, especially under the auspices of the Department of Agriculture, as explained in a later paragraph, so that at the present time the results of about three hundred such studies are recorded, while the work is still going on.

STUDY OF THE DIGESTIBILITY OF DIFFERENT FOOD MATERIALS.

The value of different foods for nutriment depends not only upon the kinds and amounts of nutritive ingredients which they contain, as determined by chemical analysis, and upon the quantities in which they are used in the dietaries of different people, but it depends also upon the proportions of the different nutrients which can be digested from the foods by persons under normal conditions as to variety and amounts of food consumed, habits of living, and general health. For this reason one very important part of the investigations in food and nutrition of man has been the study of the digestibility of different food materials, with particular reference to the proportions of nutrients that may be digested from them. This study has been made by actual experiments with men in which the coefficients of digestibility of food materials were determined from the amounts of nutrients in the food eaten and in the feces excreted.

Previous to the spread of investigations in nutrition in this country very little research had been made along this line. Even in Europe, where the study of nutrition had been carried on for many years, the number of digestion experiments with men was not large. In connection with the nutrition investigations which are being carried out by the Department of Agriculture in cooperation with experiment stations and other institutions more than one hundred and fifty digestion experiments have already been made, and at the present time some series of elaborate experiments are still in progress.

STUDY OF THE FUNCTIONS OF FOOD IN THE BODY.

One important function of food is to furnish energy to the body. For a thorough study of the laws of nutrition, therefore, and of the uses and nutritive values of food, there must be a means of determining the amounts of energy potential in the food consumed and in the products formed from the food by the body. Since different forms of energy may be transformed into heat, the energy of a substance may be expressed in terms of heat, and therefore the potential energy of a substance may be measured by the heat developed when the substance is burned in oxygen. A method is employed whereby the amount of heat thus developed by food materials is determined. The result obtained in this way is called the "heat of combustion" of the material burned. The apparatus used for this purpose is called a calorimeter, various forms of which have been devised. The early work done by the Storrs station along this line was by use of a Stohmann calorimeter, a modification of that of Thompson. This apparatus proved unsatisfactory, and the attempt was made to secure a better one. The bomb calorimeter devised by Berthelot was superior, but was very costly, because of the large amount of platinum used in its construction. With the aid of Professor Hempel, of Dresden, Professor Atwater and his associates succeeded in modifying the Berthelot apparatus, especially with regard to the amount of platinum used, so that a very accurate and satisfactory calorimeter has been obtained at a much lower cost. Mr. O. S. Blakeslee, mechanician of Wesleyan University, devised and elaborated considerable accessory apparatus, which has contributed largely to the success of the calorimeter. By the use of this apparatus the heats of combustion of a large number of different food materials have been determined.

In the study of nutrition of both man and domestic animals at the present time, considerable attention is paid to the fuel value of foods, that is, to their actual value to the body as sources of energy. This net value is taken as the heat of combustion of the total food consumed, minus the sum of the heats of combustion of the unoxidized material in the feces and in the urine. The values thus determined are used in the calculation of dietary standards, which serve to indicate in a general way the proportions of the nutritive ingredients of food that are appropriate for people in different conditions.

Studies of some of the more fundamental laws of animal nutrition have been carried on for the purpose of determining what uses the body makes of its food under different conditions. Special inquiries of this nature were begun by Professor Atwater and associates in 1892 by means of an apparatus known as a respiration calorimeter, so arranged that a man may spend a number of days in comparative comfort within it, and so manipulated that the metabolism of both matter and energy in his body may be determined. In devising and perfecting the apparatus and in carrying out the investigations with relation to the measurements of heat and mechanical work, Professor Atwater was assisted by Dr. E. B. Rosa professor of physics in Wesleyan University. Dr. F. G. Benedict, instructor in chemistry, and

Mr. O. S. Blakeslee were also important contributors to the development of the apparatus, and Dr. Benedict has had a very important part in the experiments made with it. Several years were spent in the development of this apparatus and the elaboration of methods of experimenting with it. By the winter of 1895–96 the apparatus was considered accurate enough to justify its use in experiments with men, and several experiments were made in which determinations of the metabolism of matter were made with considerable accuracy. The determinations of the metabolism of energy, however, were not considered sufficiently accurate. As experience in the use of the calorimeter was gained several improvements in the apparatus and in methods of manipulation were made, until the results finally obtained were as accurate as those secured in investigations on a much smaller scale, in which ordinary laboratory methods are followed. Later experiments are furnishing definite, accurate information concerning the action of the fundamental laws of the conservation of matter and of energy in the living organism. The results already attained show remarkable agreement in income and outgo of both matter and energy in the bodies of men at work and at rest, with different kinds and amounts of food, thus giving very exact indication of the ways in which food performs its functions in the body. These results are exceedingly valuable from the standpoint of both pure science and practical utility.

NUTRITION INVESTIGATIONS UNDER THE DEPARTMENT OF AGRICULTURE.

The greater part of the investigations in the food and nutrition of man above referred to as carried on previous to 1894 were made by the aid of contributions from private individuals,[1] though funds were supplied by the Storrs experiment station, and more especially by the Smithsonian Institution and the United States Fish Commission, through Prof. S. F. Baird, and by the United States Department of Labor, through Commissioner Carroll D. Wright.

As early as 1890 the results of the nutrition investigations already made had aroused so much public interest that steps were taken to induce Congress to appropriate funds for carrying on the work. Nothing definite was accomplished there, however, until 1894. In that year the act of Congress providing appropriations for the experiment stations and authorizing the inquiries which they were to conduct was changed so as to include the study of the food of man. The experiment stations were called upon to report progress in the work to the Secretary of Agriculture. At the same time Congress provided a special appropriation of $10,000 "to enable the Secretary of Agriculture

[1]Among the contributors may be mentioned Hon. J. W. Alsop, M. D., I. E. Palmer, and A. R. Crittenden, of Middletown, Conn., and Messrs. F. B. Thurber and E. G. Blackford, of New York.

to investigate and report upon the nutritive value of the various articles and commodities used for human food." The prosecution of this inquiry was assigned to the Office of Experiment Stations, and Professor Atwater was appointed special agent in charge of the nutrition investigations. In the following year the appropriation was increased to $15,000, which amount has been provided annually since then. The State of Connecticut, by act of legislature of 1895, also makes an annual appropriation of $1,800 to Storrs experiment station, the larger part of which is to be expended in the study of nutrition.

THE PRESENT COOPERATIVE NUTRITION INVESTIGATIONS.

The work in charge of the Office of Experiment Stations is carried out largely in cooperation with scientific and educational institutions and philanthropic organizations in different parts of the country. Extended series of investigations have been prosecuted in Maine, Connecticut, New York, New Jersey, Pennsylvania, Virginia, Tennessee, Alabama, Missouri, Indiana, Illinois, Minnesota, North Dakota, California, and New Mexico. The Department of Agriculture has cooperated in New York City with the Association for the Improvement of the Condition of the Poor and the Industrial Christian Alliance in studying the food and nutrition of the people of the congested districts. Similar work has been done with Hull House in Chicago. The Polytechnic Institute and the Tuskegee Institute in Alabama and the Hampton Institute in Virginia have made investigations in their regions, particularly among the negroes in the Black Belt of the South. In other localities experiment stations, colleges, and universities make investigations among people of various classes and conditions of life, including not only dietary studies but also other phases of the subject of the nutrition of man.

The method of cooperation adopted in the prosecution of these studies has some very decided advantages, particularly in the fact that so many different institutions, representing the varied interests of people in widely separate regions, unite in a study of prevalent conditions and an effort for improvement. Besides this, the funds provided from the Department of Agriculture are used economically and are often supplemented by means from other sources. By this extensive cooperation of individuals and institutions with the Department, under very favorable conditions, a large amount of valuable work is being done systematically, the results of which are made available to the public. In the judgment of competent experts, it is more thorough in its scientific methods, more extended in the scope and amount of investigation, and more useful in the distribution and practical application of its results than any other inquiry of the kind ever undertaken in this country or in Europe.

The more important topics that have thus far received special attention are the composition of food materials; the kinds and amounts of food consumed by individuals, families, boarding houses, and institutions; the digestibility of food materials, and the fundamental laws of nutrition. A variety of collateral questions have also received much attention. The results of these investigations are given in bulletins both of a popular and technical character, which are issued through the Office of Experiment Stations. The results of analyses of food materials made in the United States have been compiled and printed in a bulletin for popular use. In a revision of this bulletin, issued during the past year, the compilation was based upon over four thousand analyses, the larger portion of which were made in connection with the nutrition investigations. The results and discussion of dietary studies also appear in bulletins prepared for popular use. The results of digestion experiments and metabolism investigations with the calorimeter are given in bulletins which are more or less technical in character, intended rather for the scientific student of the subject.

FEATURES OF THE NUTRITION INVESTIGATIONS.

From the scientific standpoint, the most noteworthy feature of these inquiries is found in the researches with the Atwater-Rosa respiration calorimeter, by means of which the study of the application of the laws of conservation of matter and of energy in the human body are being carried out with a completeness not previously attained. Indications of the value of this apparatus and method of inquiry are apparent in the fact that an apparatus on the same general plan, but large enough for experiments with domestic animals, is already in process of construction at the experiment station of the State College of Pennsylvania, under the direction of Prof. H. P. Armsby, and in cooperation with the Bureau of Animal Industry of the Department of Agriculture. The Prussian Government has provided means for the construction of a similar apparatus for the Institute of Animal Physiology at Bonn, under Professor Hagemann. An appropriation under Government authorization has also been made for the construction of a like apparatus in connection with the Institute of Animal Physiology at Budapest, under Professor Tangl.

From the practical standpoint, the information gathered in the nutrition investigations is already being utilized, and the interest of economists, educators, and housekeepers in the results is constantly increasing. The results are being utilized in the determination of rations for the Army and Navy of the United States. Public institutions, in which dietaries are made up for a considerable number of persons, are likewise taking advantage of them. The New York State Commission in Lunacy, which has charge of all the public insane hospitals of that State, has employed Professor Atwater as a consulting expert on nutrition, and special studies of dietaries for these institutions are being conducted under his direction with a view to the improvement of the dietaries for the insane patients as regards both quality and economy. The usefulness of this work is by no means confined to the United States, but is extending to other countries as well.

INTEREST OF SCHOOLS AND OTHER INSTITUTIONS IN NUTRITION INVESTIGATIONS.

One especially encouraging feature is found in the interest in the subject that is being continually manifested by progressive educators. There is much reason to hope that gradually the results of these inquiries will find place in regular public school instruction, and thus become a part of the common knowledge of the community.

In the last report of the Bureau of Education it was stated that 146 cities in the country have introduced into the curricula of the public schools some form of manual training, many other cities contemplate it, and it will doubtless soon be a part of our school system. The form of this training at present offered to girls is in the main cooking, but there is a growing feeling among educators that it is the science of nutrition and plain facts about food in its relation to healthful living that should be taught.

Schools of domestic science and schools of cookery each year pay more attention to the scientific side of nutrition, and in a number of instances have undertaken investigations of considerable practical importance as well as scientific value.

A number of schools and colleges have taken up the study of dietaries with a view to improving the diet of their students or making it more rational. The same is true of charitable institutions, hospitals for the insane, prisons, and other institutions where a large number of people must be fed. In such institutions it is, of course, desirable to make the diet sufficient in amount and suited to the needs of the persons consuming it. It is obvious that a small saving per capita is a matter of considerable importance in the aggregate. In several instances a study of the kind and amount of food consumed has shown that such a saving was possible while at the same time the diet was materially improved.

An examination of the files of medical journals and scientific periodicals published in this country shows that the earlier volumes contained few articles on investigations of nutrition, the chemistry of food, and similar topics; whereas the total number of such articles published in similar journals within the last few years is quite large.

Requests for bulletins and information received by the Department of Agriculture from schools, clubs, and individuals show that the interest in nutrition investigations is not confined to any one region or to persons following any special line of work, but that it is general and widespread. Offers of cooperation in food investigations are frequently made by universities, schools, and individual workers, and it would be quite possible to extend the work and very materially increase the total output of American investigations on this line, provided more funds were available for the purpose.

REACTION OF DEPARTMENT OF AGRICULTURE NUTRITION INVESTIGATIONS UPON SCIENTIFIC RESEARCH.

The reaction of this inquiry upon scientific research and the scientific spirit in institutions where investigations are being carried on deserves special mention. It has been the policy of the Department of Agriculture to encourage inquiry by investigators and organizations, and in institutions whose own resources in the form of money and of labor can be devoted to the purpose, the funds supplied by the Department being regarded as supplementary. In this way the appropriation by Congress becomes to a considerable extent a fund for aid of scientific research. Two important advantages are evident in such a policy. On the one hand, the amount and value of the product, and consequently the direct benefit to the community, are very much larger than could otherwise be obtained from like expenditure of public funds. On the other hand, the aid thus given by the Government to research in different parts of the country is a very important stimulus, encouraging professors of institutions to undertake and trustees to support inquiries which without such aid would not be undertaken, and enabling gifted and aspiring students to enter fields of original inquiry such as will be useful to both themselves and the public as well as to the cause of science in general.

THE PRACTICE OF FORESTRY BY PRIVATE OWNERS.

By Henry S. Graves,

Superintendent of Working Plans of the Division of Forestry.

INTRODUCTION.

The general movement in the United States in favor of conservative forestry began about twenty-five to thirty years ago. During this time, through the medium of newspapers and magazines, Government and State publications, and scientific and other associations, the importance of a strong federal and State forest policy has been emphasized, and private owners have been urged to adopt careful methods of handling their woodlands. Some of the results of this agitation are well known, such as the withdrawal from sale of about 47,000,000 acres of public land to be held as federal forest reservations, the establishment of State reservations in New York and Pennsylvania, the institution of a system of fire patrol in Maine, New York, New Hampshire, Minnesota, Wisconsin, and Pennsylvania, the appointment of forest commissioners or similar officers in Maine, New Hampshire, New York, Pennsylvania, Minnesota, Wisconsin, and Kansas, the organization of two forest schools in the East and two in the West, as well as the establishment of courses of lectures on forestry in many agricultural colleges, and the creation of a lively interest in the subject throughout the country. What effect the efforts of the advocates of forestry have had on the handling of private woodlands is, however, not known to the general public, many believing that, with the exception of a few conspicuous examples, real forestry has not been practiced at all. As a matter of fact, a large amount of work has been done along the lines of conservative forest management, although it has not been known under the name of forestry. It is nevertheless a fact that wherever land is managed with the intention that it shall yield repeated crops of timber, and is so treated that the producing power is maintained at a high point, there true forestry is practiced.

A large number of owners in nearly every State have carried on work which comes entirely within this definition of true forestry, but their holdings are for the most part comparatively small. The majority of the large owners, the lumber companies, have not cut their forests with reference to the future production of timber, except in some of the spruce sections of the Northeast. Throughout the far West, and in many parts of the East, the danger from fire is so great that most owners have not dared to leave money invested in the forest in the form of small growing trees which otherwise might be utilized with present profit. In other sections, notably the Lake States, the taxes are so high that many owners could not afford to hold the land for future crops of timber, even if there were no danger from fire. In such localities it has been the object of lumbermen to remove the timber as soon as possible, with no intention of ever cutting over the land a second time. This system of lumbering, together with the great destruction of the forests by fire, has given the impression that there is no careful forestry in this country at all, and the work of the many small owners and of the few large owners who have managed their lands conservatively has been overlooked. It is the purpose of this paper to review briefly the work already done by private owners along the lines of forestry, much of which, though lacking system and imperfect in methods and results, shows the intention of true forestry and marks a great advance in the treatment of our forests.

In order to come in touch with private owners who have carried on such forest work as has been described, the Division of Forestry issued a circular letter of inquiry regarding the prevailing methods of handling woodlands. Answers were received from about 2,000 persons from forty-six States and Territories, nearly 1,000 of whom stated that they had done some work which might be classed as forestry. The material was so voluminous that only a general account of the work can be given here, with special reference to the more instructive examples.

EARLY EFFORTS OF PRIVATE OWNERS.

The earliest attempt at conservative forestry of which the writer has record was made in Connecticut in 1730, when Jared Eliot, of Guilford, in connection with Governor Bulkley and a Mr. Livingston, of New York, started a small blast furnace at Old Salisbury. The wood used in making the charcoal needed in the furnace was cut from the neighboring woodlands, and instead of clearing the forests, as was usually done, a careful system of thinning was adopted. Only the large trees were cut, while the small specimens were left standing to shade the ground and to grow to a larger size. Tradition states that under this system the owners returned for successive crops every twenty years, and it is reported that timber is still being cut periodically from this same land. A similar system of careful cutting is said to have been used by a large number of farmers in New England early in this century, and the practice was without doubt inaugurated very soon after the country became thickly settled. Some farmers went further than simply to select with care the trees which they wished to use or sell, and made thinnings with the sole view to improve the remaining trees. Thus, it appears that in 1840 B. F. Cutter introduced on his land in Pelham, N. H., a system of improvement cuttings. It seems that an abandoned field had sprung up to white pine and gray birch, and that when the trees were about 20 years old the birches began to be broken by the wind and to die. Wishing to save the wood before it decayed, Mr. Cutter cut out all the birch, leaving the pines untouched for twelve years longer. He then saw that a considerable number of the latter were being crowded out and were dying from lack of growing space and light, and accordingly he thinned out all the weak and unlikely trees, leaving the strong, vigorous specimens for the final crop. His labor was repaid by the wood which he took out and the improvement of the remaining trees, which grew more rapidly on account of the increased amount of light and space.

The planting of forest trees on waste lands was begun in Massachusetts at a very early date. It is said that between 1740 and 1750 an experiment in planting trees for ship timber was made at Pembroke, Mass. Tradition relates that the plantation was a complete success, and that timber was cut from it about 1810. Another early plantation was made in Bristol County, Mass., in 1790, where a farmer stocked a field with young oaks by sowing it with acorns. One of the first experiments in planting of which there is record was made in 1819 at Chelmsford, Mass., where Rev. J. L. Russell transplanted a large number of pitch-pine seedlings from a field, which he wished to cultivate, to a stretch of barren drift sand. He was much laughed at by his neighbors, but to their astonishment the trees flourished, and in twenty years he had a fine grove of pines, 6 to 8 inches in diameter. Of still greater interest and value as an illustration is the plantation of Zachariah Allen, at Smithfield, R. I., who planted about 40 acres of waste land in 1820 with chestnut, oak, hickory, and locust. The seed was sown in plowed furrows on the smooth ground, and in rough places was dropped in holes made by a hoe or a similar implement. A careful account of all expenditures and receipts was kept, and at the end of fifty-seven years the books showed a profit of 6.92 per cent on the capital invested. Similar plantations were doubtless made in the early part of the century, but no definite record of them can be obtained.

Planting on a large scale was begun in eastern Massachusetts in the present century as early as the forties. The best known of the plantations are those of Richard Fay, at Lynn, who planted about 200 acres, in 1846–1850, with oak, ash, maple, Norway spruce, Scotch pine, and larch, and of Joseph S. Fay, at Woods Hole, who a few years later stocked about 125 acres with trees. On Cape Cod it has been the custom of the farmers for many years to sow the seed of pitch pine on waste lands. The method is to sow the seed with a machine or by hand in plowed furrows about 4 feet apart. The cost is estimated to average \$3 to \$5 per acre. While pitch pine is the tree most commonly planted, oak, ash, and other species have also been used. The plantations in eastern Massachusetts are being investigated by the

Massachusetts Forestry Association, and records have already been obtained of 10,000 acres of land artificially stocked with trees. (Pl. XXV, figs. 1 and 2.)

CAREFUL THINNING.

In many sections of the country planting by owners of small holdings is very important and should be encouraged in every way possible, but the proper care of the existing woodlands is of much greater importance. Many observing farmers have already studied this problem and manage their wood lots with great intelligence. (Pl. XXVI, fig. 1.) The extracts which follow were selected from a large number of letters written by farmers in nearly every section of the country and are given to illustrate the character of the work done.

A farmer in Rochester, Mass., writes as follows:

> Ten years ago I began to cut all trees except white pine. I trim the trees as high as a man can reach easily, namely, 6 to 8 feet, leaving all limbs on the ground. I leave the outside trees, which are exposed to the sun, as a protection to the trimmed trees. I thinned and pruned the trees when about 20 years old, leaving about 200 per acre.

The following statement was received from a farmer at Wrentham, Mass.:

> About thirty years ago I began to cut out the dead and unthrifty timber; also cut inferior kinds to give more room to the better ones. Cut early in winter, before deep snow interferes with the work of picking up and hauling. Never cut at the edges of a wood lot, but leave thick growth to act as a wind-break. Do not cut the same land each year, but only so often as dead wood or inferior growth makes it worth going over with ax and team.

An owner in Granville, N. Y., writes that his grandfather began in 1850 the method of work shown in the following extract:

> I go over each lot and select such trees as I consider to be ripe, including all of any size with broken or dead tops. These trees I blaze or mark with an ax. I then send men to cut these trees and instruct them to use care in felling not to injure any young trees if they can avoid doing so. The tops I have worked up, so as to leave the ground clear for the next growth.

This careful work is by no means confined to the Northeast, but letters were received from men in nearly every State to the effect that a very large number of farmers endeavor to use conservative methods in cutting their wood lots. Thus, one farmer writes from Tennessee:

> 1. We use all the timber that blows down.
> 2. We cut any that seems to be diseased or dying.
> 3. We take the crooked, knotty, scrubby trees.
> 4. If we need more wood when the above kinds are used, we cut the oldest trees that seem to do the least growing.

A Virginia correspondent states:

> For fuel I cut the old, dead, gnarled, crooked, and unshapely trees, leaving the straight, vigorous, and more valuable. When cutting for fence material, I take only one or two here and there, thinning out to give others more room. Tops, logs, brush, etc., are burned in winter and ashes spread among growing trees.

FIG. 1.—WHITE-PINE GROVE IN WHICH THINNING AND PRUNING HAS TAKEN PLACE. PLYMOUTH, MASS.

FIG. 2.—PLANTATION OF WHITE PINE, EIGHTEEN YEARS OLD. SOUTH ORLEANS, BARNSTABLE COUNTY, MASS.

FIG. 1.—A PITCH-PINE PLANTATION, ESTABLISHED BY SOWING. EAST BREWSTER, MASS.

FIG. 2.—LAND CUT PERIODICALLY FOR SPROUTS, WITH YOUNG GROWTH IN THE FOREGROUND. BARNSTABLE COUNTY, MASS.

A Michigan man writes that he marks all the trees he wishes to leave standing and cuts the remainder, piling and burning the brush.

A California farmer writes as follows:

In the winter season, when time will admit from farm work, I cut out all the poorest growth, leaving only thrifty trees, about 200 to the acre. I draw all brush to some clear ground and burn it. I burn all chips and trash and obtain a large amount of ashes, which I throw around my apple trees.

CAREFUL CUTTING OF SPROUT LAND.

It is well known that most hard woods send up sprouts from the stump, especially if the trees are cut before the sap begins to run in the spring. (Pl. XXVI, fig. 2.) Many farmers take advantage of this fact, and cut their woodlands clear, and then wait fifteen to thirty years for a second crop of sprouts. It is common to hear this practice vigorously condemned, but as a matter of fact, it is one of the established systems of forestry used in Europe as well as in this country. For the production of firewood it has many advantages; and if the cutting is done carefully, the growth will frequently amount to not less than 1 cord per acre per annum. Thus, New England farmers calculate that about twenty-five years are required for cleared sprout land to produce 25 cords of wood per acre. This system has been in practice since the early settlement of the country, and in many places old oak stumps may be seen from which repeated crops of sprouts have been cut and which have become, under the treatment, gnarled, misshapen, and covered with irregular knobs. As a rule, no precautions are used to assist in the prolongation of the life of the stumps, but the correspondence of the Division of Forestry shows that a considerable number of men have taken this point into consideration in cutting their sprout lands. Thus, a New Jersey farmer writes that he cuts his stumps slanting from the center like the roof of a house, taking care not to injure the bark. In this way no rain water is allowed to collect on the stump and thus hasten its decay. A number of correspondents stated that they are accustomed to cut the stumps close to the ground, so that independent roots will be formed and the wind will not break off the sprouts, as would often be the case with high stumps. Letters were received from many farmers stating that they always cut the trees in winter, as the stumps are apt to lose their sprouting power if cut during the growing season.

CONSERVATIVE LUMBERING.

The most extensive work in forestry by lumbermen has been done in the spruce forests of New York and the New England States. The pioneer of this movement was E. S. Coe, of Bangor, Me., who saw very early that if only the large trees were cut and the small ones left standing, the land could be cut over at repeated intervals. In letting contracts, therefore, he restricted the cutting to 10, 12, or even sometimes to 14 inches on the stump. As a result he cut over certain tracts a second time and obtained as large a cut as at first, using the same diameter limit. A large number of owners have followed his example and limited the cutting of spruce to a certain size, but so far as the writer is informed the cuttings have not been regulated in a systematic way, except on the tracts belonging to Dr. W. S. Webb and Hon. W. C. Whitney, in the Adirondacks, where the land has been lumbered under a system devised by the Division of Forestry. The usual method of the lumberman is to issue instructions to the choppers not to cut trees under a certain diameter on the stump, and later on the stumps in the woods or the butt logs on the landings are measured in order to see that the regulation has been complied with. On the two tracts just mentioned, however, not only is there a diameter limit for the cutting, but all trees are marked which are to be cut, and seed trees above the specified size are left when necessary. The lumbering is strictly regulated according to the following rules, and competent inspectors are employed to see that they are rigidly carried out:

(1) No trees shall be cut which are not marked.

(2) All trees marked shall be cut.

(3) No trees shall be left lodged in the woods and none shall be overlooked by the skidders or haulers.

(4) All merchantable logs which are as large as 6 inches in diameter at the small end must be utilized.

(5) No stumps shall be cut more than 6 inches higher than the stump is wide.

(6) No spruce shall be used for bridges, corduroy, skids, slides, or for any purpose except building camps, dams, or booms, unless it is absolutely necessary on account of lack of other timber.

(7) All merchantable spruce used for skidways must be cut into logs and hauled out.

(8) Contractors must not do any unnecessary damage to young growth in lumbering; and if any is done, they must discharge the men who did it.

The International Paper Company has within a few years adopted a system of restricting the cutting of spruce on a part of its lands in Maine, New Hampshire, Vermont, and New York. The method is to cut no spruce under 12 inches in diameter on the stump. Fir, however, is cut clean in order to reproduce the ground to spruce. On one tract of 120,000 acres, in New Hampshire, an inspector has been employed to watch the lumbermen to see that they do not cut any small spruce for lumbering purposes, except for camps, bridges, dams, cribs, piers, and corduroy. On a considerable amount of land, however, this company cuts the spruce clear without regard to the future production of timber.

An interesting method of forest work is that used in the southern part of New Hampshire, near Lake Winnepesaukee, where the lumbermen, in a number of cases, have left white pine trees for seeding purposes. The trees are usually spreading, scrubby specimens, which are of no great value, but which, nevertheless, would bring a small price for box boards. The lumbermen calculate that about two to five good seed trees of pine per acre, evenly distributed, usually secure an excellent natural reproduction. It is the custom, therefore, to leave standing not less than two or three spreading trees per acre.

Some of the lumbermen in Maine, in cutting second growth white pine, leave standing all trees under 12 inches in diameter, and calculate that they can return for a second crop in about twenty years.

In the Allegheny Mountains much of the lumbering does but little damage to the forest. This is usually not due to a conscious intention on the part of the lumbermen to protect the forest, but is because only a limited class of timber can be sold. Thus, one man in West Virginia writes that he cuts only the white oak, poplar, and walnut, leaving all trees under 23 inches in diameter. He states that he takes great care not to injure the young growth; that he is now cutting over a tract of 1,200 acres for the third time in twenty-six years, and that he expects to remove his fourth crop in five years more.

A novel plan of forest work has been initiated by the owner of about 4,000 acres at Kendalia, W. Va., who wishes to combine forestry with stock grazing. He is thinning the entire tract, removing the dying, overripe, or otherwise unlikely trees, and leaving all thrifty, sound specimens of all species. He then clears the underbrush and sows the ground to blue grass. The thinning is to be completed within a year or two, and the work of clearing and sowing to grass will be done gradually. It is the owner's intention to utilize the farm permanently for stock and to hold the growing timber as an investment for the future. The owner is making the experiment with the full understanding that the future value of his forest lies in the growth attained by the small trees now standing, and that when these trees are cut there will be no provision for natural reproduction. The work was begun in 1898, and 10 acres were treated in the way described in order to ascertain the expense and to test the behavior of the grass. It appears to be an entire success.

As illustrating the kind of forestry practiced by certain lumbermen in the South, the following letter is of interest:

I have just commenced to cut off 700 acres near Ohatchee, Calhoun County, Ala. I go over the land, cutting all the trees down to a diameter of 12 inches at the stump, or 2 feet above the ground. I leave all the oak and pine (longleaf yellow pine) and cut down all other growths clean, and leave the woods clean with the exception of the timber I leave to grow larger. These small trees are then thick enough, or as thick as they should be, to grow fast. I cut from this land about twenty large trees to the acre. This in log scale makes about 9,000 to 10,000 feet to the acre. I burn this land off every year, some time when the sap is not up, or any time between November and February. There are never enough leaves to make enough fire to hurt the timber by burning it once a year. I am very careful in cutting this large timber to fall it so as not to inflict wounds on the trees to stay on the ground, as this will leave defects in the timber when it is cut, say twenty years from now. I do not leave small trees unless they have straight bodies, so when they grow up they will be useful timber. Inside of five years I will begin to leave sprouts that appear, so as to form another growth after this timber, now being left, is ready to cut. I use this land after it is cleaned up for sheep and hog pasture.

The instances of conservative lumbering described in the preceding pages are but examples of work which has been carried on by a large number of lumbermen. The systems have been devised by the owners themselves, and, while in many cases improvements could be made, the work shows that much more has been done in the way of forestry than is generally supposed.

FOREST MANAGEMENT UNDER SYSTEMATIC WORKING PLANS.

It has been said that forestry consists in managing woodlands with the expectation of obtaining repeated crops of timber. Systematic forest management requires, first, the determination of the amount of timber that can be obtained at different periods, and, second, the management of the forest in accordance with a definite plan which shall secure the greatest returns in the long run.

In most instances the conservative forest management hitherto practiced in this country has been without system, and the owners have not known whether or not the methods used were successful in maintaining the productive power of the land. The first large forest put under systematic management with a definite working plan was that belonging to G. W. Vanderbilt, at Biltmore, N. C. The work was organized in 1891 by Gifford Pinchot, now the Forester of the Department of Agriculture, on about 4,000 acres. Additional tracts have since been purchased to the extent of about 100,000 acres, and the whole area has been brought under systematic treatment. An expert forester is employed to superintend the work, and there is a corps of trained rangers. A certain amount of mature poplar has been lumbered, and the system of cutting employed has been very successful in bringing about an excellent reproduction of that tree. Improvement cuttings of various species, chiefly for cord wood, are made in the portions of the tract nearest the market, and a certain amount of planting is done every year. The tract is admirably protected from fire, theft, and stock grazing, and a complete system of roads and trails is being laid out.

A great deal of the work which is being done at Biltmore would not be practical on many other large tracts (managed solely for profit) in other sections or even in the same section of the country. The kind of systematic forest management practical for lumbermen will be more along the lines practiced on the Webb and Whitney tracts, in the Adirondacks, already mentioned in the discussion of conservative lumbering.

During the past year a considerable amount of systematic forest work has been organized on private tracts under advice from the Division of Forestry. This has been the result of an offer made in October, 1898, by the Secretary of Agriculture for the Division to give advice and assistance to private owners in handling their woodlands. Within a year after the offer was made applications were received from owners in thirty-five States for assistance, the total area covered by these applications being about 1,600,000 acres. The preparation of working plans for these tracts and the supervision of their execution is now one of the important branches of the work of the Division of Forestry.

FOREST FIRES.

The first condition necessary for successful forestry is an adequate protection from fire. In sparsely settled countries, where there are large unbroken stretches of forest, this is the first problem to be solved, and until the danger is reduced to a minimum owners will not lumber with reference to the future.

In farming countries, where the holdings are small and interspersed with fields and roads, the fires can be successfully prevented by careful watching. Hitherto the majority of owners of both large and small tracts have relied chiefly on careful watching and, in case of a fire, on extinguishing it before much damage is done. Further precautions are, however, now coming into use, such as clearing wood roads, burning fire lines, piling and burning tops after cutting, etc. Some of these measures are practical only on small woodlands, but those who have tried them write enthusiastically of their success.

A farmer in Pennsylvania describes his method of protection as follows:

> I make fire lines 2 perches wide. Just before fall of leaf I cut brush to prevent return of sap. In spring I sprinkle with water to limit the extremes of fire and burn the space inside. Each year the growth is less and grass begins to grow. The cost of cutting brush is $3 to $4 per acre.

An owner of a farm on one of the small islands off the coast of Maine writes:

> We cut two strips across narrow places and cleared all brush, so that the grass would grow and, if necessary, in case of fire, the land could be plowed. The work was started five years ago and the wood nearly paid expenses. This method was adopted because of the danger of fire on the outer ends of the island, where fishermen frequently camp, and we feel that in case of fire on a point we could fight it and keep it from the best part of the island.

A Michigan farmer makes a practice of cutting roads through the forest, harrowing and seeding them to grass, and then allowing stock to graze on them. The system was initiated in 1885, and in the judgment of the owner the expenditure of about $100 per annum has been a profitable investment.

The construction of fire lines around and through the wood lot is practiced by farmers in many sections of the country. The custom is especially common among Western farmers on the plains, who have made artificial plantations. In the South the same system is used, but farmers more often burn over the whole of their land every year.

The most disastrous fires occur on large tracts, where the construction of fire lines would in many cases be impracticable. The methods used by lumbermen and other large owners to protect their property are, therefore, of special interest. The most common method, where any attempt at fire protection is made, is an organized fire patrol. Thus, some companies operating logging roads have men follow every train during the dry season to extinguish any fires that may be set by the locomotives. Other companies have extra rangers during the dry times who patrol the woods, watch campers, and in case of fires repair to them at once.

This system is well illustrated by the following letter from a lumberman in Forest County, Pa.:

In dry times we patrol especially exposed parts. In spring and autumn, during dry weather, our woodsmen all have orders, no matter what they are doing, whenever they see smoke arise, to go to it and put out the fire. It is usually done by back-firing entirely around and watching it until we are sure the fire is out. By this means we have kept serious fires from our timber when we are working. It costs us a few hundred to a thousand dollars annually. Usually successful, but not always. The outlay is profitable.

The most perfect system of fire protection in this country known to the writer is that used by Dr. W. S. Webb on his tract of 40,000 acres (Nehasane Park) in the Adirondacks. The park is divided into four sections, each watched over by an experienced woodsman, who lives at a point from which all parts of his section can be easily and quickly reached. The houses of the rangers are connected by telephone, and there is an admirable system of roads and trails. In case of fire in the park, the superintendent and the rangers are notified by telephone, and all available men are called out to extinguish it. In case of a severe fire along the railroad which traverses the park, Dr. Webb is notified by telegraph, and a locomotive is dispatched to draw the "fire service" to the scene. This consists of a large tank placed on a flat car, to which is attached a box freight car containing a small engine used to pump the water from the tank, and a complete outfit of hose, axes, and other tools used in fighting fires.

A lumberman owning 2,000 acres in Huntingdon County, Pa., describes his method of fire protection as follows:

I divide into lots say 200 acres, cut roads through, and rake all rubbish and burn it before the season gets too dry. This makes good fire-breaks. When very dry I put a watchman on for every 200 acres. The first year's cost was $400; that of succeeding years $60.

The owner pronounces the above method entirely successful, and is confident that the outlay has been profitable.

FIG. 1.—A PLANTATION OF PITCH PINE, ABOUT FIFTY YEARS OLD. SOUTH ORLEANS, BARNSTABLE COUNTY, MASS.

FIG. 2.—A GROVE OF WHITE OAK ESTABLISHED BY DROPPING THE ACORNS IN HOLES MADE WITH A CANE. EAST GREENWICH, R. I.

A Pennsylvania lumber company writes:

In dry times we have men watch exposed places; also have 100-barrel tank on a car, with 600 feet of 2½-inch hose. Two streams can be thrown from this tank, as there is a powerful pump attached with two connections for hose. In 1898 we expended $900 fighting fire before we rigged up the tank. This year, with more fires, the expense has not exceeded $100, and we have been able to control every fire. Not over 10 acres have been burned over this season as against 200 last year.

A Michigan man writes that he burns the tops of the felled trees in wet weather after he has finished logging, and states that the measure has been successful in protecting his timber land. He also says that after an experience of twelve years he considers the outlay a good investment.

One owner of 30,000 acres in Clark County, Wis., has for six years made a practice of clearing up and burning the tops after lumbering, and considers it a practical and profitable undertaking.

In the pine belt of the Atlantic coast it has long been the custom for many owners to let a light fire run through the forest annually, or once in several years. The fire is set in winter or early spring, when the ground is damp and it can be kept under control. The measure is very successful in protecting the standing timber, but in many cases it destroys the young seedlings, and the ultimate effect on the forest is injurious. The method of burning used in the turpentine forests is shown by the following letter from Louisiana:

We rake the dry straw (needles), grass, and chips from the base of the trees, about 3 feet all around, and the woods are burnt within the time prescribed by the Mississippi law, to lessen the growth of grass. The work was begun about eight to ten years ago, and cost about $120 for 1,600 acres. The custom of raking the ground at the base of the trees is considered as part of the turpentine business. This method is adopted by nearly all turpentine producers. The raking is done with ordinary garden rakes, and has been the means of preventing many forest fires. The raking is commenced about one week before Christmas or earlier, if the straw is done falling, and continues all through January.

The cost of raking and burning is estimated by the crop. About 10,000 boxes constitute a crop, and the cost of raking and burning is about $12 per crop. I work about 10 crops every year, and pay on an average $120 to have them raked and burned properly: and the outlay, in my judgment, has proven both wise and profitable.

The custom of burning over the forest in winter or early spring is also common among lumbermen and farmers in California and other Western States.

FOREST PLANTING.

The great bulk of the forest planting has been done in the States west of the Mississippi River. In the Eastern States, except in a few instances, the planting has been on a very small scale and usually as an experiment. Reference has already been made to the extensive planting in eastern Massachusetts, where not less than 10,000 acres have been artificially restocked with forest trees. (Pl. XXVII, fig. 1.) Nowhere else in the country, so far as the writer is informed, has so much planting been done on so limited an area. Record has been obtained of a large number of farmers who have planted from 1 to 10 acres, and there are a few instances of planting on a more ambitious scale. The plantations described in the following pages are but a few of many instances, but they show the kind of work which has been done.

An interesting plantation is that belonging to Isaac Adams, at Moultonboro, N. H., covering altogether about 50 acres, and composed of white pine and Norway pine set out about twenty-five years ago. The trees have grown admirably, and, so far as showing what planted pine will produce, the experiment is very valuable. The cost of planting in the first place was, however, much more than it would be to-day.

The experiments of J. D. Lyman, near Exeter, N. H., who planted several acres of waste land with pine, are of considerable value, because he was able to show that the cost of stocking land with trees can be reduced to about $3 to $5 per acre. His method was to sow the seed in hills 4 feet apart and to put from three to five seeds in each hill.

A very instructive plantation has been established by Mr. H. G. Russell, at East Greenwich, R. I., covering about 150 acres. (Pl. XXVII, fig. 2.) Like many American planters, he began with imported trees, namely, Scotch pine, Austrian pine, and Norway spruce, but later used native species. The work was begun in 1878, the intention being to form a wind-break, and in addition to provide an object lesson in forest planting.

The most extensive planting in Pennsylvania has been done by the Girard estate, near Pottsville. About 250 acres were set aside in 1881 to be treated under the methods of forestry. This tract was fenced and surrounded and crosscut by fire lines wherever there existed no roads adapted for that purpose. The trees used were white pine, Scotch pine, European larch, and white oak. The cost of planting varied from $18 per acre for the pines to $75 for the oaks. The planting of trees on the barren gravel at the edge of the reservoirs is of special value.

Another interesting experiment in planting in Pennsylvania has been undertaken by the Morrison and Cass Paper Company, at Tyrone. About 2,000 Carolina poplars were planted in 1898, at an expense of $534.50. About half the trees were 10 to 16 feet high and the remainder somewhat smaller. They were planted 12 feet apart in rocky, worthless land.

The planting of trees along the banks of streams to prevent erosion has been undertaken in a number of instances. Thus, in Arkansas a correspondent states that he has planted red birch, native willows, and soft maple for 2 miles along a stream to prevent the washing of the banks. The plants were seedlings about 2 years old and were taken from the woods. Similar work has been done at Mahwah, N. J., on the estate of Theodore Havemeyer.

A CATALPA PLANTATION.

In Ohio tree planting was begun very early. In 1830 Ezra Sherman, of Preston, planted about 15 acres of locusts, as well as an avenue along the public highway for about 200 rods. In 1870, 180 trees were cut down and 1,500 posts were obtained, netting $525. A certain amount of planting on a small scale is now done by farmers in Ohio, Indiana, and Illinois, but most of it is for the purpose of forming wind-breaks.

In most sections east of the Mississippi the natural reproduction of the forest is so abundant that planting has been little resorted to. Thus, where the loblolly pine flourishes the abandoned fields are often entirely seeded in a few years to young trees. So prolific is this regeneration that it has long been the custom in certain sections of the South to allow worn-out land to spring up to pine, and when the trees are 30 to 50 years old to clear and cultivate the land. Thus, there is a regular rotation of field and forest crops.

Natural reproduction is very prolific throughout the humid regions of the country, and old fields, if not pastured or continually burned over, eventually return to forest. Planting is very desirable for small owners, who, by the expenditure of a small amount of money or labor each year, can gradually stock the waste portions of their farms, but for lumbermen and other large owners planting on an extensive scale will, in the majority of cases, not be profitable.

On the Western plains, where timber is scarce and has a high market value, tree planting is very important, and it is here that the great bulk of the work has been done (Pl. XXVIII). Extensive tree planting on the plains was begun about twenty-five to thirty years ago. Several States, notably Iowa, Kansas, Wisconsin, Nebraska, Missouri, Minnesota, Illinois, Nevada, and the Dakotas, passed laws about that time encouraging, by bounty or exemption from taxation, the planting of forests. In 1873 the timber-culture act was passed by Congress providing that a title could be obtained to 160 acres, or a proportionate part thereof, by those who planted 40 acres or a proportionate area. While the State laws had but little immediate result and the timber-culture act was frequently a source of fraud, an impulse was given to tree planting, and the great amount of work which has been done must be traced largely to the effects of these legislative acts.

The correspondence of the Division of Forestry shows that a large number of farmers have planted trees for wood lots or wind-breaks in all the Western States. The greatest amount of work seems, however, to have been done in Kansas, Nebraska, and Iowa. The estimate given for the total planted area of Kansas in 1898 by the State board of agriculture was 159,859 acres. The total planted area in the other States has not been determined, but this question, as well as the results of the experience obtained in tree planting, is under investigation by the Department of Agriculture.

Tree planting on the Western plains was taken up not only by small private owners, but also by a number of the railroads. In 1870 the Kansas Pacific Railroad experimented with tree planting on a small scale in Kansas, and in 1873 the Atchison, Topeka and Santa Fe Railroad established four stations, planting altogether about 70 acres. The Northern Pacific Railroad established an experimental station of 40 acres at Casselton, N. Dak., and the Burlington and Missouri and the St. Paul and Sioux City railroads in the early seventies planted considerable stretches with trees to act as wind-breaks and snow-breaks. A certain amount of experimental work was also done by the St. Paul and Pacific Railroad. The most important plantation made by railroads was that belonging to the Kansas City, Fort Scott and Gulf Railroad at Farlington, Kans. The following interesting letter with reference to the work has recently been received from the firm that furnished the trees:

We furnished the trees for the Kansas City, Fort Scott and Gulf Railroad (now the Kansas City, Fort Scott and Memphis Railroad) and for the president of the above road. This plantation [railroad] is at Farlington, Kans., and the Hunnewell plantation is 4 miles west of Farlington. At first the railroad bought the trees and the section men planted them. Possibly 50,000 trees were so planted up to 1878. We sold Mr. Nettleton, the general manager of the road, chestnuts, walnuts, and wild black cherry (a total of 12,500), white ash, and European larch. In 1878 we grew for them, under contract, 100,000 *Catalpa speciosa* and 25,000 black walnuts. In 1879 we took the contract of planting the balance of the section, they to furnish land for us to grow the seedlings on and to break the prairie sod and cross plow it when rotted; we to then plant and take care of the trees until they were from 4 to 6 feet high. They were planted 4 by 4 feet, 2,722 to the acre; we to get 1½ cents per tree when turned over. A large part—at least three-fourths—of the trees planted was *Catalpa speciosa*. A large number of *Ailanthus glandulosa* were also planted. These two kinds of trees did well. The chestnut, larch, white ash, and wild black cherry were an almost utter failure. Over 3,000,000 plants were set out. In 1881, I believe, we sold the Iron Mountain Railroad 200,000 catalpas.

In California the planting of eucalyptus has proved very profitable to a large number of farmers. The tree was introduced in 1856, and as early as 1874 there were estimated to be about 1,000,000 specimens of eucalyptus in California. No recent estimate of the acreage of plantations has been made.

No mention has been made of the planting of sand dunes at Cape Cod, Mass.; at the Golden Gate, San Francisco, and Casmalia, Cal., nor of the planting at various experiment stations throughout the country. This is all work of great value, but it is not private forestry, and it has, therefore, not been considered in this paper.

GROWTH OF THE TOBACCO INDUSTRY.

By Milton Whitney, *Chief*, and Marcus L. Floyd, *Tobacco Expert*, *Division of Soils.*

TOBACCO GROWING PREVIOUS TO THE PRESENT CENTURY.

Tobacco was grown in this country long before the arrival of the first settlers. It early attracted the attention of the colonists, and for nearly two centuries was identified with their social, economic, and political development, especially in Maryland and Virginia. In Maryland it was made legal tender in 1732 (at the rate of 1 penny per pound) for all debts, including customs dues and the salaries of State officers and ministers of the gospel. The yield of tobacco in that year was 30,000 hogsheads for Maryland alone. As late as 1777 the tax levied for Baltimore County and city was fixed at 172 pounds of tobacco per poll.

THE INDUSTRY IN MARYLAND AND VIRGINIA.

At the beginning of the present century the dark export types of Virginia and the light pipe-smoking tobacco of Maryland were the only classes of tobacco grown in this country. It has been within the present century that the cigar, the lemon-yellow cigarette, the mahogany manufacturing, the Burley, and Perique types of tobacco have been developed. Samples of Maryland and Virginia tobaccos are shown in Pls. XXIX and XXX.

In 1812 the demand by foreign countries for colored tobaccos was so great that artificial heat was employed in curing. In this way the piebald, or spangled, tobacco of Virginia was developed. Until 1828 wood fires were the only artificial means known of curing tobacco. About this time flues and charcoal fires began to be used. It was not until 1865 that flue curing entirely superseded charcoal fires in the production of the bright yellow varieties, now so popular and used as cigarette, plug, and twist wrappers.

In 1825 the amount of tobacco produced in Maryland was about 15,000 hogsheads; in 1846 it was 41,000 hogsheads, and in 1860 it was 51,000 hogsheads, this being the largest yield ever produced in that State. During the civil war the yield decreased, and in 1865 it was only 25,000 hogsheads. In 1878 the yield again increased to 46,000 hogsheads, while in 1890 the lowest production of the State was recorded, 14,000 hogsheads. In 1892 the yield rose to 27,000 hogsheads. The Maryland tobacco is consumed principally in Holland, France, and Germany.

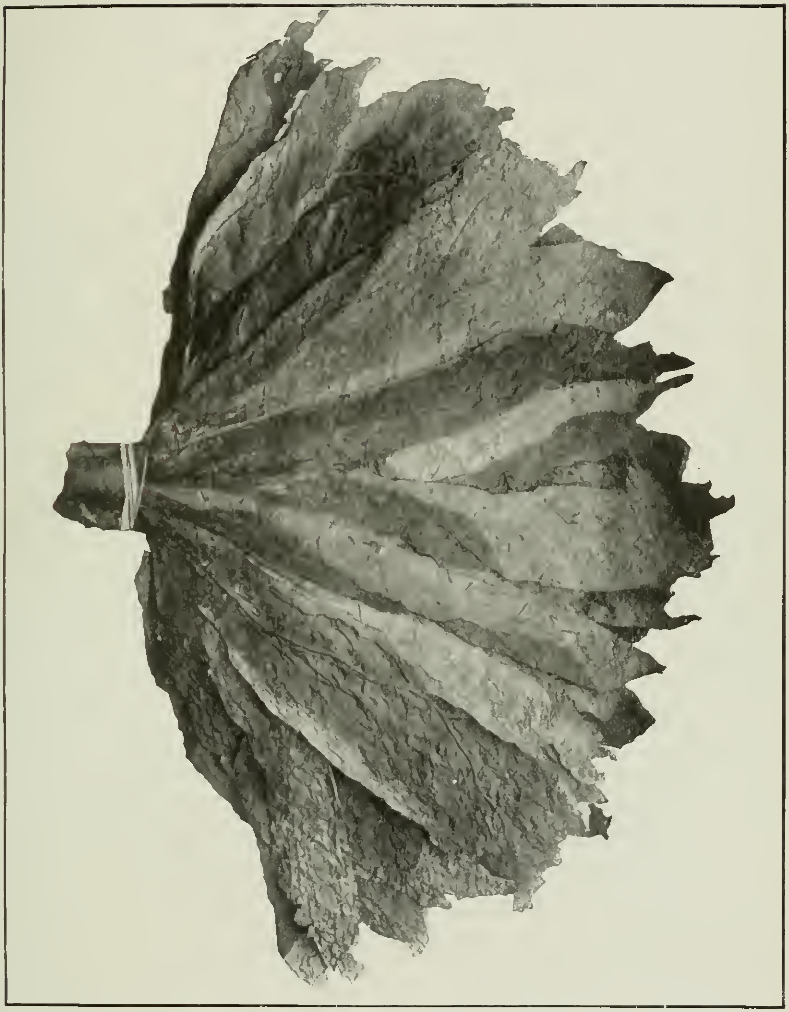
EXTENSION OF THE INDUSTRY.

Although some tobacco was grown during the time of the early settlements in Pennsylvania and New England, the first real extension of the industry was westward, in Kentucky and Tennessee. In 1785 tobacco production was of considerable importance in northern Kentucky and the adjoining counties of Ohio, while in the central and southern portions of Kentucky and Tennessee this industry came into prominence about the year 1810. The tobacco produced here was the dark, export type that has always prevailed in these localities. Up to the year 1833 by far the largest part of the tobacco grown in these two States was sent by the planters in boats to New Orleans for shipment to foreign countries. In that year, however, warehouses were established in Clarksville, Tenn., and soon others sprang up in Louisville, Ky., and in the surrounding towns of these States.

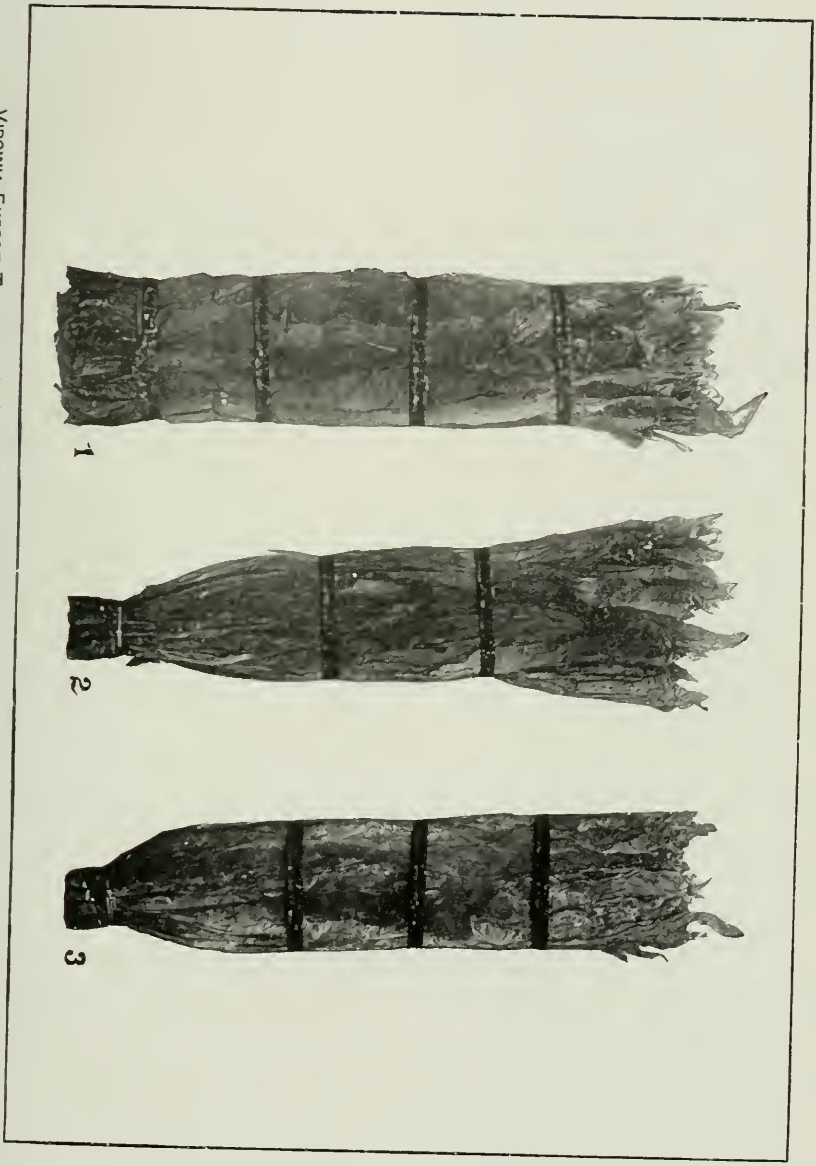
The first crop of lemon-yellow tobacco was produced in 1852 on a sandy ridge in Caswell County, N. C. (See Pl. XXXI.) This tobacco was received with such special favor that its cultivation spread rapidly in Caswell County and also in Pittsylvania County, Va. During the civil war there was almost an entire abandonment of its production, but after the war attention was again called to this tobacco as being very desirable for plug fillers and wrappers. As flue curing came into general use about this time, a much superior article was produced. The price rapidly rose with the increase in the demand, and the cultivation extended into other counties in North Carolina and Virginia and spread into South Carolina and eastern Tennessee. In 1876 there were 43,000 acres planted in this tobacco, yielding 20,000,000 pounds; in 1879 the acreage was 57,000, yielding 26,926,000 pounds. Since that time this tobacco has continued to grow in popularity and the increase in acreage still continues.

The manufacture of cigarettes began about 1864, in which year 19,770,000 were made. These apparently did not take well, as in 1869 the number of cigarettes manufactured was only 1,750,000, but since that time the annual output has steadily and rapidly increased.

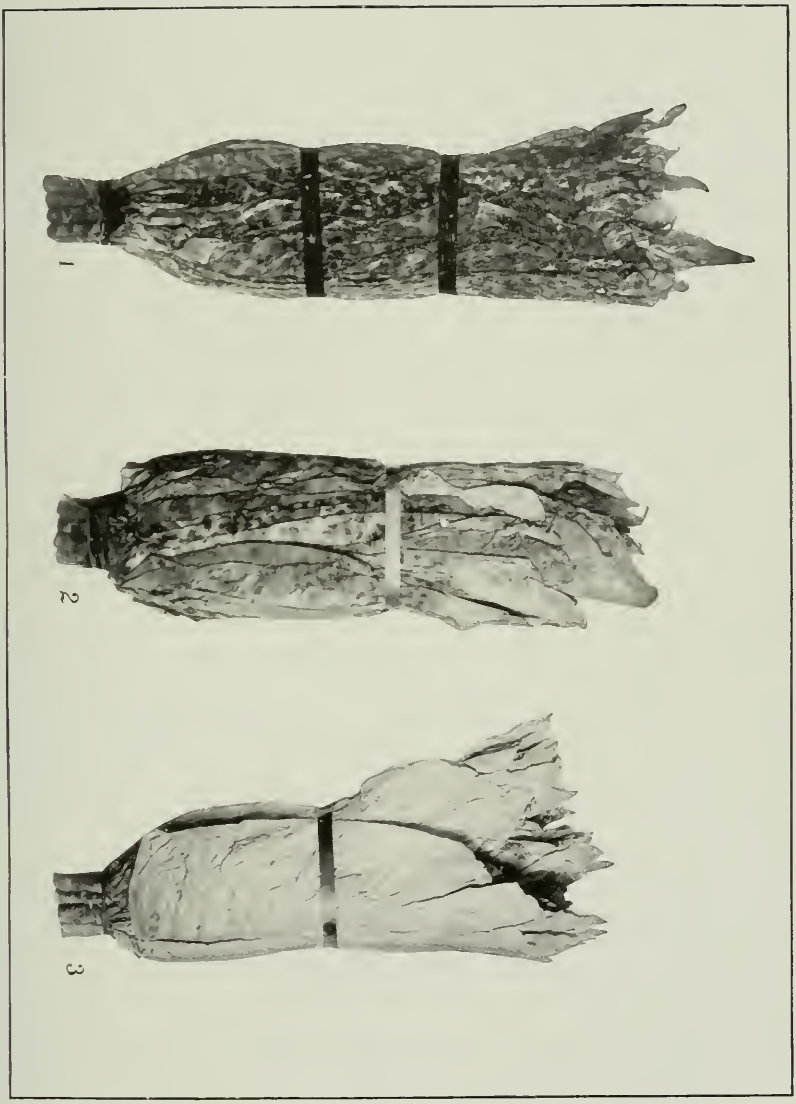
In 1864 the White Burley tobacco was originated through a sport from the Red Burley in Brown County, Ohio. This tobacco at once found favor as coming midway between the light smoking varieties of Maryland and the dark export types of Virginia, Kentucky, and Tennessee. On account of the absorbent powers of this leaf, it is particularly well adapted to plug fillers and plug and twist wrappers. The finer types are used for cigarette cutters and wrappers, while the light, flimsy, overripe bottom leaves are used for pipe smoking. The cultivation of this tobacco rapidly extended over the limestone area



MARYLAND SMOKER: BRIGHT "COLORY" LEAF.



VIRGINIA EXPORT TOBACCO: 1, ENGLISH OLIVE-GREEN STRIPS; 2, OLIVE-GREEN LEAF; 3. AUSTRIAN A.



CIGARETTE AND MANUFACTURING TOBACCO: 1, DARK MAHOGANY; 2, LIGHT MAHOGANY; 3, BRIGHT LEMON-YELLOW.

of southern Ohio and the central and northern sections of Kentucky. The cultivation of this tobacco is still confined to the limestone soil of this area. Packages of White Burley tobacco are shown in Pl. XXXII.

CONNECTICUT TOBACCO AND THE CIGAR INDUSTRY.

Tobacco was grown in the New England colonies during the years from 1640 to 1650, but from that time up to the early part of the present century it was almost abandoned. In 1825 the industry had been revived and developed to such an extent that the first warehouse was established at Warehouse Point, Conn., where 3,200 pounds were packed and shipped to New York. In 1840 tobacco became a general crop, about 720,000 pounds being produced in the Connecticut Valley. In 1842 the yield had increased to 2,000,000 pounds, and in 1845 to 3,450,000 pounds, at which time the cultivation was extended into the Housatonic Valley. About 1833 the broad-leaf variety, having a silky, delicate leaf with regular veins, nearly tasteless and of fine texture and finish, was originated. (See Pl. XXXIII.) Previous to 1845 the price ranged from 7 to 4 cents per pound, but in 1847 it rose to 40 cents per pound.

During the first part of the present century the Connecticut tobacco was recognized as being essentially different from the Virginia types, and it began to be used in the manufacture of cigars. About 20,000 pounds of tobacco were produced in the Connecticut Valley in 1801, about which time the making of cigars was begun in a small way, the first factory being established in 1810. During the early development of this industry cigars were peddled through the country in wagons. It was about this time that the first importation of Cuban cigars of any consequence was made.

The following shows the gradual increase in the number of cigars manufactured in the United States from 1860 to 1892:

Number of cigars manufactured in the United States in 1860, 1875, 1885, and 1892.

	Number
1860	199,000,000
1875	1,926,000,000
1885	3,358,000,000
1892	4,518,000,000

The first tax on cigars, chewing and smoking tobaccos, and snuff was imposed by act of Congress of July 1, 1862, which took effect September 1 of the same year. The first tax on cigarettes was imposed in 1864. Licenses for dealers and manufacturers were not required until 1868.

INTRODUCTION OF TOBACCO IN VARIOUS STATES.

PENNSYLVANIA.—The cultivation of tobacco in Pennsylvania began in 1689, but little attention was paid to the industry until 1828, when it began to be of commercial importance. In 1840 Pennsylvania produced 325,000 pounds of tobacco in York, Lancaster, and Dauphin counties, the present tobacco centers of the State. In 1845, in consequence of the Mexican war and the increased value of wheat, the cultivation of tobacco declined; but it developed rapidly between 1849 and 1859. In 1859 the yield was over 3,000,000 pounds. There was little increase in the yield until 1870; and in 1879, 36,900,000 pounds were produced, at which time Pennsylvania ranked third among the tobacco-growing States of the country.

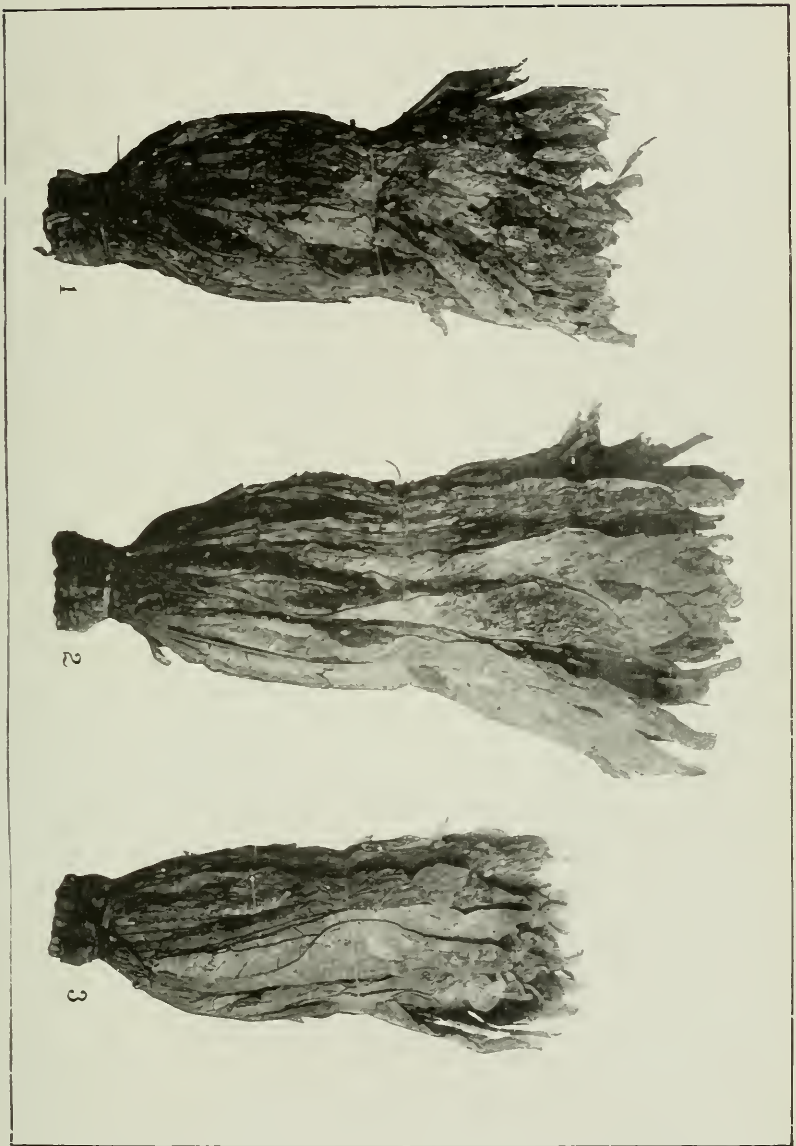
OHIO.—Cigar tobacco was first grown in Ohio in 1838, seed having been brought from Connecticut. In 1850 some 800,000 pounds of the seed-leaf variety were produced. During the years 1863, 1873, and 1880 the yield reached 1,200,000 pounds. The Little Dutch was introduced into Ohio from seed imported from Germany about 1869. In 1879 the total yield of this variety was about 500 cases. The Zimmer Spanish (Pl. XXXIV), a hybrid of the Cuban variety, was introduced about 1878. The Little Dutch and Zimmer Spanish, especially the latter, found great favor as cigar fillers. This largely increased the production of these tobaccos, supplanting to a considerable extent the seed-leaf variety.

NEW YORK.—The introduction of tobacco into New York State occurred in the year 1845; in 1855 Onondaga County alone produced 500,000 pounds, and in 1863 the cultivation had greatly extended and had reached considerable importance in several counties. From 1862 to 1864 New York tobacco brought a good price, selling for as much as 30 cents per pound. From this time on the price has varied greatly, ranging from 5 to 25 cents, and at times even to 30 cents per pound. In 1879 the crop of the entire State was estimated at 6,480,000 pounds.

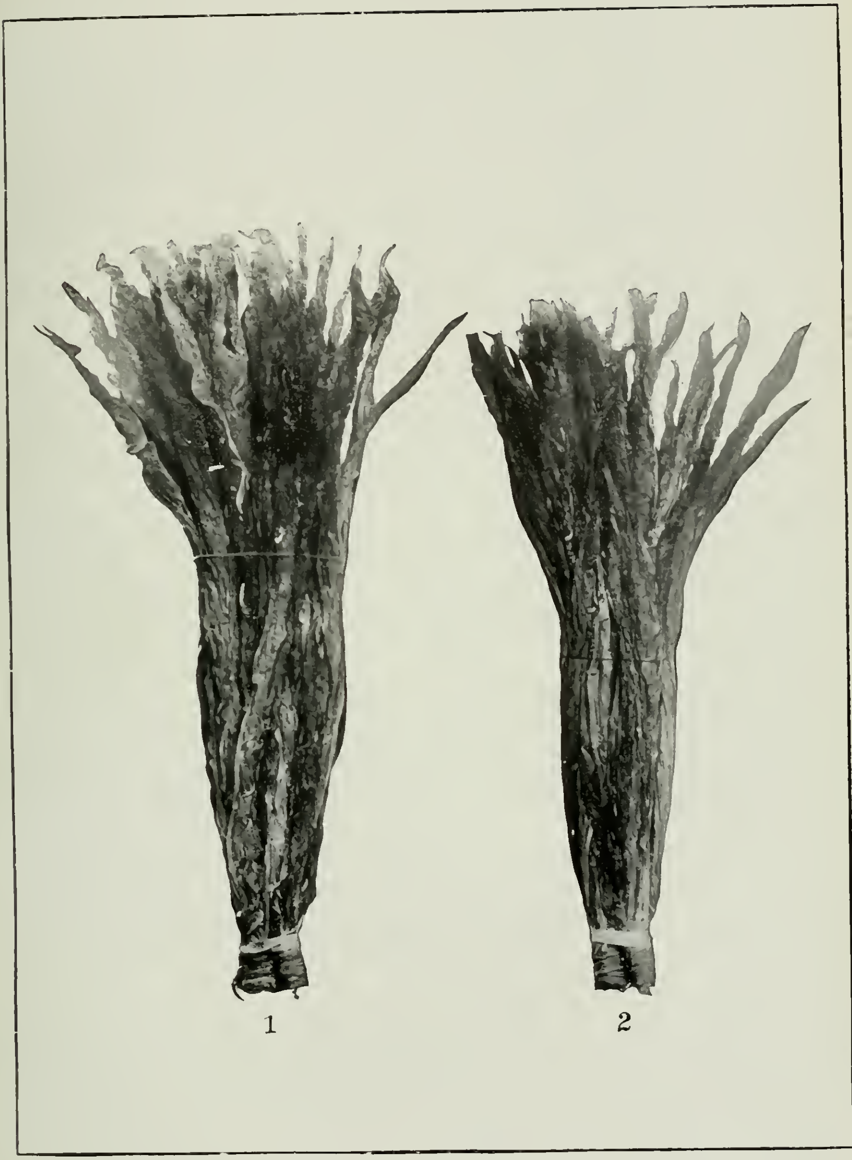
WISCONSIN.—Tobacco was introduced into Wisconsin in 1850, when 1,260 pounds were produced; in 1860 the yield was 87,000 pounds; in 1870 it was 960,000 pounds, and in 1889 it was 19,123,000 pounds.

FLORIDA.—Tobacco was introduced into Florida about the year 1829; ten years later this tobacco had taken a place of considerable importance as a cigar-wrapper leaf, being especially noted for its broad, silky, beautifully spotted leaf. This is still remembered as the "Old Florida speckled leaf," the cultivation of which was entirely abandoned at the outbreak of the civil war. About the year 1888 attention was again called to the possibility of producing a desirable cigar leaf in Florida; but with the importation to this country of the Cuban tobacco, which began in large quantity in 1860, and of the Sumatra four years later, the market had changed and the "Old Florida" was no longer acceptable to the cigar trade. The Cuban and Sumatra types have formed the basis of the present development of the tobacco industry in Florida. (Pl. XXXV.)

LOUISIANA.—The culture of tobacco was begun in the State of Louisiana about the time of the settlement of New Orleans. In 1752 the

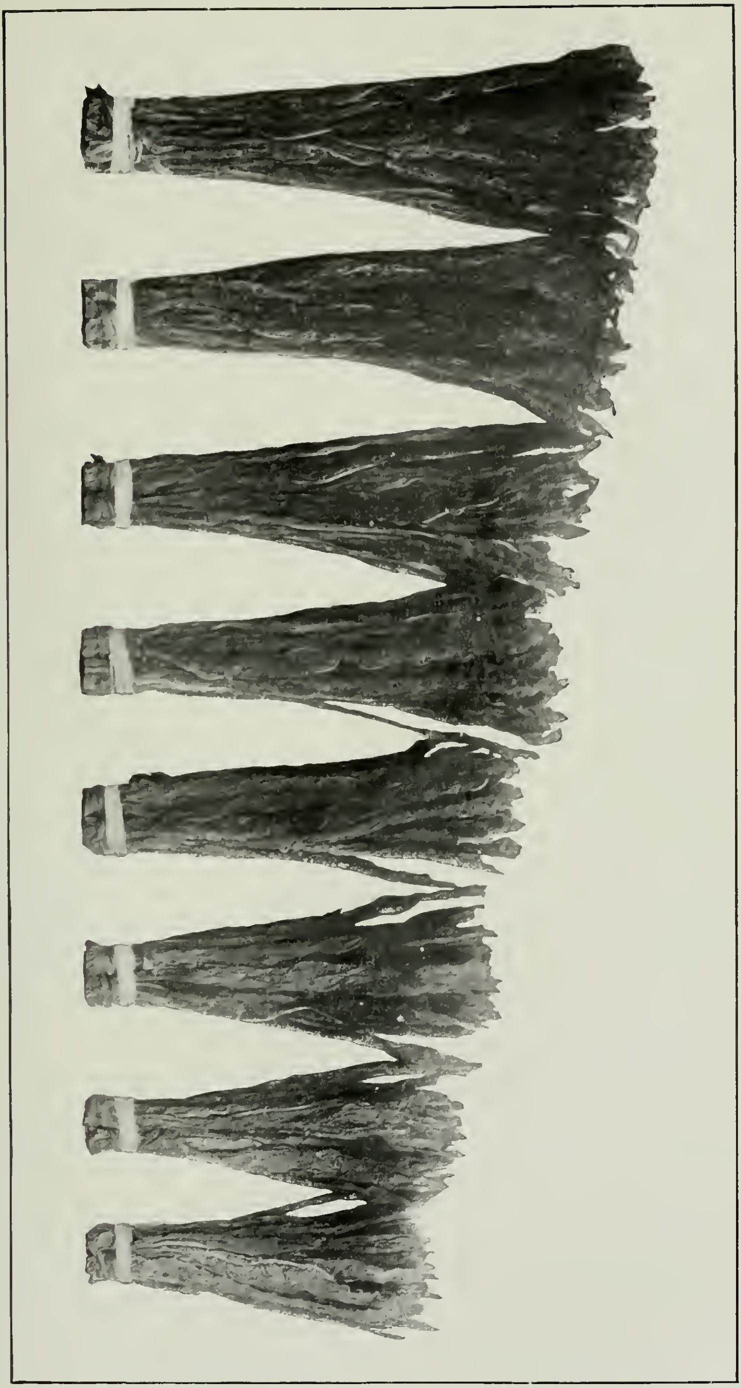


WHITE BURLEY TOBACCO: 1, FLYER, OR TRASH; 2, GOOD LEAF; 3, RED TOP FILLERS.



CONNECTICUT CIGAR-WRAPPER LEAF: 1, BROAD LEAF; 2, HAVANA SEED LEAF.

PLATE XXXIV.



OHIO ZIMMER SPANISH CIGAR-FILLER LEAF.

Government of France offered to purchase all of the tobacco raised in that province at a price equivalent to $7 per hundred pounds. During 1793 and 1794 the production of tobacco was stimulated by the ravages of insects on the indigo plant, which, previous to this time, had been a staple crop. In 1802, 2,000 hogsheads of tobacco were exported from New Orleans, and the culture had extended along the Mississippi River as far north as Natchez. As this tobacco had no particular excellence, it was soon supplanted by the Kentucky and Tennessee tobaccos, which were of a much superior quality. In 1824 the Acadians introduced a new method of curing, by which the tobacco was cured, under intense pressure, in its own juice. This Perique tobacco, for such is the name of the Louisiana variety, while very strong, has peculiar properties which are acceptable to pipe and cigarette smokers, especially when mixed in small proportions with other tobacco. On account of the long and laborious method of curing, the cultivation has never extended beyond two or three parishes in southern Louisiana; nor has it been placed upon a successful commercial basis, except among the Acadians. The greatest yield of this tobacco in any one year has not exceeded 100,000 pounds, and, until recently, the average yield was about 50,000 pounds. The price of the Perique tobacco had been uniformly $1 per pound, until the extension of the area under cultivation within the last few years; since then the price has fallen to about half that amount.

REQUIREMENTS OF THE FOREIGN TOBACCO TRADE.

THE IMPORTANT COUNTRIES FOR THE AMERICAN TRADE.

The most important countries for the American tobacco trade, in the order of the quantity used, are Great Britain, Germany, Italy, Canada, Spain, Austria, Switzerland, France, Belgium, Holland, Africa, Mexico, Central America, South America, and the West Indies. Each country differs in its requirements and also in the character of the leaf used. As all of these countries are supplied from the same section, and as the differences in the tobaccos to a casual observer are slight, it requires considerable experience on the part of the packer to assort the various tobaccos into the grades suitable for each country and to put the goods in the condition required by the particular country for which they are intended.

QUALITIES REQUIRED.

In the matter of quality Great Britain requires the best leaf and pays the highest price; Austria comes next; while Italy, France, and Spain follow in the order named. Great Britain demands a large leaf, olive green in color and so heavily smoked in curing that the odor of hard wood is apparent in the leaf. (Pl. XXX, figs. 1 and 2.) The green tint is secured by harvesting the leaf before it is fully ripe.

A tobacco that gives promise of being suitable for the English market is harvested at an earlier stage of ripeness than for any other country. On account of the high import duty (about 87 cents per pound) on tobacco imported into England, it is usually stemmed before leaving this country and packed very dry.

Austria takes two grades of leaf—the Austrian A (Pl. XXX, fig. 3), a large leaf, medium to light brown in color, of medium body, and about 26 inches long; and Austrian B, a leaf of about the same quality, 22 inches long.

Italy takes four grades of tobacco. The Italian A is practically the same as the Austrian A, except that preference is given to a dark-brown color, and is used for the same purpose, that of cigar wrapper. Italian B is the same as Italian A, only shorter; Italian C1 is a dark, short, heavy-bodied leaf, used for cutting purposes; while Italian C2 is a trashy lug.[1]

France requires three grades. The French A is a leaf 20 inches long, which, in Virginia, is made black by steaming and hard pressure in the hogsheads while hot; French B is the same grade as French A, 18 inches long, while French C is a smooth lug, 16 inches in length, used principally for snuff. Formerly the French Government took the best heavy-bodied tobacco of Virginia, but since the Regie contract system[2] has been introduced the quality of the leaf used has gradually lowered.

Spain uses very little of the Virginia tobacco, requiring a leafy lug, which can be obtained to a better advantage in Kentucky and Tennessee. That country uses four grades, differing in length, cleanness, and soundness of the leaf.

Africa takes a long, narrow leaf of heavy body, which is made very black by steaming and packing under heavy pressure in the hogshead while the tobacco is still warm. Oil is applied by means of a sponge to each layer as it is packed. This same grade of tobacco is also used in the Canary Islands and West Indies, and is packed in a similar manner, except that the oil is omitted.

All dark export tobaccos are cured with open hard-wood fires, the English trade demanding extra heavy smoking in curing. There is a slight difference between the export tobacco of Virginia and that of Kentucky and Tennessee. The Virginia tobacco, generally speaking, is of better quality than the Kentucky and Tennessee grades, and more of it is used for the domestic market. On account of the high import duties of some of the foreign countries and the low prices paid by the Regie Governments, the better qualities of these tobaccos are used in this country for manufacturing purposes.

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[1] Lugs are the second pair of leaves from the bottom of the plant.

[2] The term applied to the system under which in certain countries a tobacco monopoly is maintained by Government and all purchases of leaf tobacco are made by Government agents.

The farmer assorts the tobacco roughly into lugs, good leaves, and top leaves; but the final grading and treatment are given by the packer, who also decides to which country the various qualities of tobacco shall be sent. If the tobacco needs darkening, to meet the demands of any particular trade, the desired shade is obtained through various ways of manipulating and packing the tobacco.

MANUFACTURING AND SMOKING TOBACCOS.

The light tobaccos produced in Maryland are air cured, while a similar type grown in eastern Ohio is largely cured by wood fires. These tobaccos are used exclusively for pipe smoking and cigarettes, the following grades being made by the packers: Fine yellow, medium bright, good ordinary "colory," fine red, fine seconds, medium seconds, and lugs. Nearly all of these goods are exported, the best markets being found in France, Germany, Holland, Austria, and Belgium.

Almost the entire yield from Maryland and eastern Ohio is sold in Baltimore, where five large warehouses have been established for the inspection of these goods by State officers. As soon as these tobaccos are entered in the warehouse a sworn and bonded inspector draws four samples from each hogshead, taken from different places and at equal distances apart, beginning near the bottom of the hogshead. These four samples, or hands, are tied together, as shown in Pl. XXIX, and are sealed and labeled with the name of the owner, the number of the hogshead, its net and gross weight, and the name of the inspector. The agents of foreign countries buy exclusively from these samples; when the goods are shipped the samples are also forwarded, so that the goods on reaching their destination can be compared with the samples from which they were bought. If there should be more than 10 per cent of tobacco in the hogshead poorer than the sample, the inspector, who is under bond, becomes liable for such difference.

The White Burley (Pl. XXXII) is entirely air cured, except in exceedingly damp weather, when wood fires may be used. This tobacco is assorted by the farmer into the following grades: Flyers, the first two bottom leaves, which are overripe and very trashy; common lugs, the next two leaves; good lugs; bright leaves; long red; short red, and top leaves. This tobacco is packed in hogsheads by the farmer and inspected in the same manner as the Maryland tobacco, but, unlike the latter, it is sold at auction in the warehouse.

Not more than 10 per cent of the White Burley is exported, but on account of its great absorbent powers it is highly prized in this country for twist and plug chewing tobaccos. The flyers are used for pipe smoking, the heavy-bodied top leaves for plug and twist fillers, while the best leaves are used for cigarette, plug and twist wrappers, and for cutting purposes.

The bright yellow and mahogany tobaccos (Pl. XXXI) are cured entirely by flues, a method which cures very quickly, not more than four days being required in the process. As soon as the tobacco is put into the barn the fire is started and is kept going night and day until the tobacco is thoroughly cured to the desired color. This tobacco, which is sold at auction in loose piles in the warehouse, is largely consumed in this country, being used for plug and twist wrappers, cigarettes, and finecut chewing and smoking tobaccos. The broad scope of this type makes it exceedingly popular and the acreage is rapidly increasing. Recently this tobacco has come into favor with foreign countries, Japan having lately placed a large order for this grade.

DOMESTIC CIGAR TOBACCOS.

The cigar types are almost entirely consumed in this country, and, in addition, large quantities of Cuban and Sumatra tobacco are imported. Domestic cigars are made up of wrappers, binders, and fillers, which come from different districts. The Connecticut Valley produces two types of wrapper leaf, the broad leaf and Havana seed leaf (Pl. XXXIII), both varieties being air cured, packed in cases holding about 300 pounds, and left to ferment during the winter, spring, and summer months. This tobacco is sampled and sold at private sale, the packing usually being done by those who buy the tobacco from the farmers.

The broad-leaf variety has a broad silky leaf, very elastic, about two-thirds of the leaf from the tip possessing rich grain and color. Small veins are also a characteristic of this leaf. There is only one small area in the Connecticut Valley adapted to the production of this type.

The leaf of the Havana seed is smaller than the broad leaf, much narrower, and is exceedingly thin and silky, but possesses less elasticity and covering quality. It does not possess the rich grain of the broad leaf; the middle and lower parts are glossy and have large veins. This portion of the leaf is not desirable for wrapper purposes. The heavier leaves and those slightly damaged or of uneven color are used as binders. Badly torn leaves and the trash are not suitable even for fillers, but are sold at a low price for export tobaccos. Both the broad leaf and Havana seed are graded into light, medium, and dark wrappers, and light and dark seconds, all grades being arranged in four lengths. The Connecticut wrapper competes with the imported Sumatra, being the nearest to it of any of the domestic tobaccos except that grown in Florida from the Sumatra seed.

The tobacco produced in Pennsylvania is characterized by a long, broad leaf. It is air cured and packed in the same way as the Connecticut Valley tobacco. The Pennsylvania tobacco has a dark, heavy-bodied leaf, unsuited for wrappers, but used mainly for fillers and binders. Some good wrapper leaf is grown on the light alluvial soils near the rivers. As a filler leaf this tobacco competes with the Zimmer Spanish, Little Dutch, and Florida-grown Cuban, and it is used mostly in the production of stogies, cheroots, and other low-priced cigars. This tobacco is assorted by the packers into the following grades: 18-inch, 20-inch, 22-inch, and 24-inch light and dark wrappers and binders, the shorter sizes being graded as fillers, and called Pennsylvania B's.

The New York tobacco comes between the Pennsylvania and Connecticut leaf, and contains a small percentage of desirable wrapper leaf. It is graded and packed in a manner similar to that employed in Connecticut.

Wisconsin produces only a binder leaf, which is frequently used with the Connecticut wrapper and the Pennsylvania or Ohio filler. It is graded and packed like the Connecticut tobacco.

Ohio produces mainly a filler crop of Zimmer Spanish and Little Dutch varieties. The Zimmer Spanish is a small leaf, in appearance closely resembling the imported Cuban tobacco. This type was originated about twenty years ago, since which time it has rapidly grown in favor as a filler for domestic cigars, being considered by the trade the best filler leaf grown in the United States. This tobacco is graded more carefully than any other tobacco grown in this country, except that grown in Florida. The Cuban method of fermentation is being adopted by those who handle the Zimmer Spanish. The Little Dutch is a close second in popularity to the Zimmer Spanish. It is manipulated in the same manner, but the grading is not so closely or carefully made. The leaf is larger than the Zimmer Spanish, and departs further in appearance from the imported Cuban. A small quantity of seed leaf, known as Gebhard, is produced in Ohio as a wrapper leaf, but as it is inferior to the Connecticut the acreage is rapidly diminishing. The Florida-grown Cuban tobacco, which is just coming into prominence, is regarded by some manufacturers as greatly superior to the Zimmer Spanish, being nearer to the imported Havana in appearance and quality and selling at a much higher price than the Zimmer Spanish.

There are two types of tobacco grown in Flordia, one from seed originally imported from the island of Cuba, the other from the island of Sumatra. The Cuban seed has retained the characteristic size and appearance after being planted for seven consecutive crops; but the Sumatra seed, after two or three seasons, begins to assume the character of the Cuban plant. For this reason it is customary, in order to preserve the desired Sumatra characteristics, to save enough seed from the first or second crop to last for eight or ten years and to plant each succeeding crop during this period from this seed.

The Florida-grown Cuban tobacco is used especially for filler purposes. Although good wrappers are sometimes obtained, which closely resemble the best imported Cuban wrappers, there is a prejudice against these, owing to the fact that they have considerable body, thus requiring more pounds to wrap a thousand cigars. In point of usefulness and appearance these wrappers do not compare favorably with the Sumatra type.

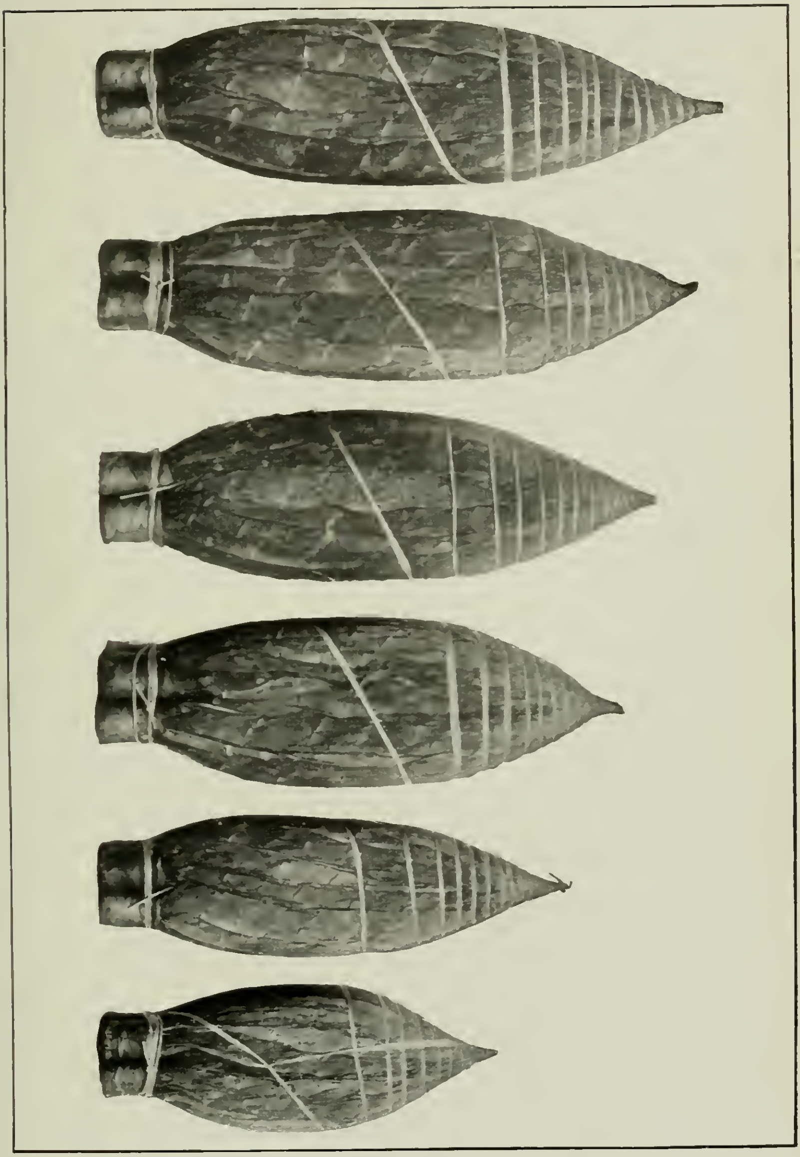
The Forida-grown Cuban filler closely resembles the imported Cuban leaf in size, shape, and general appearance. It has good body and aroma, although the specific aromatic quality and flavor of the best Cuban tobacco have not yet been obtained. The tobacco is carefully fermented, very much as in the Cuban process, and is afterwards carefully sorted and graded according to color, body, and length. It is then made into carrots (see Pl. XXXV) and baled in identically the same way as the Cuban package. This tobacco has taken well with the domestic trade, as is evidenced by the fact that it brings the highest price of any domestic filler leaf, a good packing of clean, sound leaves selling for 40 cents per pound. The Florida-grown Cuban wrapper, although constituting a very small proportion of the crop, brings from 75 cents to $1.50 per pound.

The Florida-grown Sumatra is essentially a wrapper leaf that has been highly developed during the past few years. While the first crops gave in most cases only about 20 per cent of wrappers, the proportion has now been increased to 70 and 80 per cent, under the most careful methods of cultivation. This crop is so valuable that the land is now shaded with cheese cloth, placed on wood frames 9 feet high, and irrigation is used in addition by some of the larger planters with most gratifying success. The Florida-grown Sumatra closely resembles the imported leaf in size, shape, texture, grain, and general appearance. It is extremely thin and very elastic. The most desirable sizes are 14, 16, and 18 inches. The best crops will average about 200 leaves to the pound. Two pounds will cover 1,000 cigars. This makes it a cheap wrapper for the manufacturer, even at the high price of $1.50 to $2 per pound. Choice selections have sold by the bale as high as $3 and $4 per pound, although the proportion of these very high grades is yet very small, requiring infinite care and great expense in sorting. This tobacco is all primed, that is, each leaf is picked when ripe, and great care is exercised in fermenting, grading, and assorting.

STATISTICS OF MANUFACTURED TOBACCO, SNUFF, CIGARS, AND CIGARETTES.

The total receipts by the Government, from the internal-revenue tax on tobacco from all sources during the fiscal year ending June 30, 1899, amounted to $52,043,859.05. In the fiscal year 1898 there were registered 3,186 manufacturers of tobacco, including plug, pipe smoking, and cigarette, and 115 snuff manufacturers. There were 30,856 cigar manufacturers during the same period.

The following table shows the amount of manufactured tobacco and



FLORIDA CIGAR FILLER, CUBAN SEED.

the number of cigars and cigarettes made during the past nine years, the period ending on June 30 of each year:

Statistics of manufactured tobacco, snuff, cigars, and cigarettes, 1890–1898.

Year.	Manufactured tobacco.	Snuff.	Cigars.	Cigarettes.
	Pounds.	*Pounds.*	*Number.*	*Number.*
1890	243,427,003	9,434,746	4,228,528,258	2,505,167,610
1891	259,855,085	10,674,241	4,422,024,212	3,137,318,596
1892	264,412,767	11,426,927	4,674,708,260	3,282,001,283
1893	238,587,702	11,952,736	4,341,240,981	3,666,755,959
1894	257,050,444	11,582,838	4,163,641,327	3,620,666,804
1895	263,404,840	10,887,709	4,099,137,855	4,237,754,453
1896	248,708,581	12,703,919	4,048,463,306	4,967,444,232
1897	283,320,857	13,768,455	4,431,050,509	4,631,820,620
1898	261,532,298	13,607,631	4,915,663,356	4,685,783,897

For 1899 the figures for manufactured tobacco and snuff are not obtainable separately, but the combined total for the two articles was 266,661,752 pounds. During the same year there were made 4,542,016,570 cigars and 4,590,388,430 cigarettes.

STATISTICS OF LEAF TOBACCO EXPORTED FROM THE UNITED STATES.

The following table shows the principal countries to which the American tobacco is exported, but it does not give a correct idea of the ultimate distribution of the tobacco. The amount credited to Germany undoubtedly embraces much that is sent to Austria-Hungary, Switzerland, Africa, and several other countries. The tobacco is sent to Bremen or other German ports and is distributed from there. Unfortunately, there are no reliable statistics as to the actual amount of American tobacco adapted for consumption by these different countries. On the other hand, it is quite likely that the amount credited to the United Kingdom is largely consumed in English territory. In France, Italy, and Spain, where the Regie system prevails, the tobacco is billed direct, and the estimates given undoubtedly represent the quantity of American tobacco consumed in those countries. The Regie system has lately been introduced into Japan, but this has been so recently done that the quantity mentioned in the table has not been in any way affected by the introduction of the system. The trade with Japan has increased very much in the last few years; in 1894 there were 11,084 pounds exported from the United States to that country, while in 1898 the exportation had increased to 2,751,246 pounds. The trade with China has also increased during the same period, but not to such an extent. The amounts credited to Austria-Hungary, Switzerland, and Africa are certainly far below the actual amount of American tobacco used by those countries, for the reason just stated—their distribution from German ports rather than their direct importation from this country.

Average yearly export of leaf tobacco, 1894–1898.

[Compiled from Bulletin No. 16, Section of Foreign Markets, Department of Agriculture.]

Country.	Pounds.	Per cent.	Dollars.	Per cent.
United Kingdom	81,698,086	29.21	8,181,050	34.44
Germany	53,948,979	19.29	4,062,900	17.11
France	30,553,565	10.92	2,419,595	10.19
Italy	26,430,166	9.45	2,495,974	10.51
Belgium	21,278,085	7.61	1,960,958	8.26
Spain	20,770,457	7.43	1,033,192	4.35
Netherlands	19,404,179	6.94	1,154,040	4.86
Canada	11,233,189	4.02	1,093,638	4.60
British Australasia	1,846,830	.66	270,857	1.14
Africa	1,757,846	.63	158,054	.67
Mexico	1,754,181	.63	135,295	.57
Gibraltar	1,351,909	.48	91,296	.38
British West Indies	1,350,355	.48	123,217	.52
Haiti	907,785	.32	102,168	.43
Japan	786,913	.28	54,654	.23
Sweden and Norway	721,438	.26	69,802	.29
Canary Islands	599,054	.21	51,278	.22
British Guiana	580,195	.21	44,301	.19
French West Indies	478,558	.17	38,530	.16
Denmark	176,407	.06	16,805	.07
Austria-Hungary	120,778	.04	10,305	.04
Argentina	104,751	.04	6,386	.03
China	75,426	.03	5,570	.02
Brazil	38,214	.01	4,393	.02
Other countries	1,707,730	.62	166,768	.70
Total	279,675,076	100.00	23,751,026	100.00

ADMINISTRATIVE WORK OF THE FEDERAL GOVERNMENT IN RELATION TO THE ANIMAL INDUSTRY.

By George F. Thompson,
Editorial Clerk, Bureau of Animal Industry.

PRELIMINARY REMARKS.

Diseases of domestic animals have been the subject of many articles and letters which have appeared in the Annual Reports for the Department of Agriculture since its organization, and even previous to that time in the agricultural part of the Patent Office Reports. The first investigations were undertaken by Department authority in 1868, at a time when Texas fever and contagious pleuro-pneumonia were creating considerable alarm among the cattle raisers of the country. In 1882 and 1883 the investigation of Texas fever was taken up with a view to ascertaining its causes and methods of prevention and establishing definitely the areas infected by it. However, no administrative work relative to the animal industry of the country was undertaken by the Federal Government previous to the establishment of the Bureau of Animal Industry in the Department of Agriculture in 1884, except the limited amount done by the Treasury Department at the quarantine stations at the ports of import. One of the purposes of the establishment of the Bureau was to inaugurate and supervise the federal administrative work relative to contagious diseases of animals, and the history of the work in the United States forms a large portion of the history of the Bureau.

The work of the State governments relative to animal diseases can not be given within the limits of this paper, but it is well to say that, even before the Federal Government took up the work, several States had enacted laws for the control of contagious diseases of animals. Such enactments, while they might not have been inefficient, were found to be inadequate, since the regulation of the movement of animals from State to State could only be accomplished by the Federal Government; hence, the necessity was apparent that the latter should take up the great work and cooperate with the States.

AUTHORITY CONFERRED AND SCOPE OF THE WORK.

The authority possessed by the Department of Agriculture for enforcing measures with reference to contagious diseases of domestic animals is conferred by "An act for the establishment of a Bureau of Animal Industry, to prevent the exportation of diseased cattle, and to provide for the suppression and extirpation of pleuro-pneumonia and other contagious diseases among domestic animals," which was approved by the President on May 29, 1884. The power thus conferred is not in all cases sufficient to effect the eradication of a disease, for the reason that the Federal Government can not enforce measures within a State without the legislative consent of that State, unless the animals affected are subjects of or endanger interstate commerce. Its work, therefore, without the cooperation of the States affected, is limited to interstate traffic, and quarantine lines are thus made to follow State lines. It has always been a matter of gratification, however, that wherever the Bureau of Animal Industry has undertaken to suppress and eradicate a contagious disease the authorities of the affected States have readily lent their assistance. A State, on the other hand, can do nothing more than guard its own territory; and, while all of the States have laws for the control of live-stock traffic with a view to the prevention or suppression of disease, it could hardly be expected that they would under all circumstances cooperate with each other effectually. The work of the Federal Government is therefore necessary to the State, and the State laws are necessary to the Federal Government, if success in eradicating disease from the country is to be assured; the federal and State powers are not only supplementary, but interdependent.

CONTAGIOUS PLEURO-PNEUMONIA WORK.

The success of the Bureau of Animal Industry in eradicating contagious pleuro-pneumonia from this country was a triumph that will never be forgotten by the cattle owners of the United States. This disease had become established in several States east of the Allegheny Mountains, and later broke out in Ohio, Illinois, and Kentucky, all great cattle-growing States of the Mississippi Valley. From these States it threatened to spread over the great cattle districts of the West and completely to ruin the industry. The country was thoroughly alarmed, and Congress was prevailed upon to enlarge the powers of the Bureau of Animal Industry to deal with contagious diseases of domestic animals, contagious pleuro-pneumonia being especially mentioned.

A thorough study was immediately begun of the history of the disease in this country and abroad and of the means and methods employed elsewhere for its eradication. Dr. D. E. Salmon, who became the chief of this new Bureau, speaking of this disease in 1883, had said "that the only object kept in view should be its complete extinction by the most summary measures at our command," and further: "We can recommend no temporizing measures with regard to this affection. The only ones applicable are quarantine, restriction of movement of cattle, slaughter of affected animals, and disinfection." The veterinary profession the world over was agreed as to the efficacy of these measures alone, and the Bureau desired to adopt them at once in entering upon the pleuro-pneumonia work. In fact, rules and regulations providing for the destruction by Bureau inspectors of affected animals and the certification of the assessed value of such animals to the Commissioner of Agriculture, who, upon approval, would order payment for the same, were issued by the Commissioner of Agriculture on April 22, 1885; but about the same time the Attorney-General of the United States rendered an opinion, based upon the organic act creating the Bureau, that there are "no provisions for purchasing the diseased and exposed animals," thus rendering null and void the rules and regulations of the Commissioner. However, in the appropriation act for the fiscal year of 1887 the Commissioner was authorized to expend the appropriation "in such manner as he may think best to prevent the spread of pleuro-pneumonia * * * and to expend any part of this sum in the purchase and destruction of diseased animals wherever in his judgment it is essential to prevent the spread of pleuro-pneumonia from one State to another." From that time forward the work was pushed vigorously and successfully.

In accordance with the organic act creating the Bureau and also with the appropriation act just quoted, rules and regulations, dated August 12, 1886, were formulated for prosecuting the work. Provision was made for the acceptance of these rules and regulations by the governors of the affected States, which in most instances was promptly done. In the matter of inspection, the Bureau was to furnish the necessary inspectors, who were to receive from the proper State officers the authority to make inspections of cattle under the laws of the State, to receive such protection and assistance as would be given to State officers engaged in similar work, and be permitted to examine quarantined herds wherever so directed by the Commissioner of Agriculture or the chief of the Bureau of Animal Industry. Reports upon inspections were to be made to the Bureau of Animal Industry and to the proper State authorities. When contagious pleuro-pneumonia was discovered in a herd, the owner or person in charge was at once to notify the inspector, who was to put in force the quarantine regulations of the State in which the herd was located. Every animal of an infected herd was distinctively marked with a lock and chain, which were furnished by the Bureau, but which became the property of the State when placed upon an animal, in order that anyone tampering with them would become amenable to the laws of the State. Quarantine restrictions were for a period of not less than ninety days, and were not to be removed without the consent of the Bureau. All affected and exposed animals were to be slaughtered as soon after discovery as possible, were to be appraised according to the provisions of the State law, and the representatives of the Bureau notified of the appraisement. The Department of Agriculture was to pay to the owner such portion of the appraised value as was provided by the laws of the State for cattle condemned and slaughtered by State authority. All necessary disinfection was to be conducted by the Bureau. The Bureau did not recommend inoculation for the disease, but retained supervision over the herds which were inoculated under State authority.

These regulations were modified from time to time as necessity arose. On April 15, 1887, the chief of the Bureau was authorized to inspect stock yards, cars, boats, and other vehicles of transportation lines, and to make the necessary regulations for their quarantine and disinfection. A few weeks later a notice was sent to the managers of transportation lines, calling their attention to the existence of contagious pleuro-pneumonia among cattle in Illinois, Maryland, and New York, requesting their cooperation in preventing the spread of the disease by means of disinfection and by declining to receive cattle for shipment which were not known to be free from infection. Still later this notice was modified so as to apply to all States affected.

These measures soon began to give good results, enabling the chief of the Bureau of Animal Industry to make the following statement in his report for 1888:

> The prompt eradication of pleuro-pneumonia from Chicago and vicinity is worthy of more than a simple narration of the fact. It may well be considered one of the most important results ever accomplished by the Department of Agriculture. History gives few if any cases where the dairies of a city of the size of Chicago have once been infected with pleuro-pneumonia and where the disease has been eradicated without years of constant work and the expenditure of vast sums of money. Paris was infected more than one hundred years ago, and in spite of the large number of veterinarians in that district, and of the stringent laws and regulations promulgated for its suppression, the disease still exists, and the ravages continue from year to year apparently undiminished.

At the same time the disease was eradicated from all affected districts in Maryland outside of the city of Baltimore, and in Virginia it was completely suppressed. In the other affected States the work had been most satisfactory. In 1889 the progress of the work was notable, being hampered only by lack of full authority on the part of the Bureau properly to enforce its regulations. The plague had not reappeared west of the Allegheny Mountains and no extensions occurred in the Eastern States. Cattle owners and shippers outside of the infected districts had gained such confidence in the work that the presence of the disease in this country no longer interfered with the traffic to any appreciable extent. In 1890 the chief of the Bureau reported as follows:

> The year has passed without any discovery of contagious pleuro-pneumonia outside of the districts which were recognized in the last report as infected. The regulations of the Department have been enforced without difficulty, and the progress of the work for the eradication of this plague has been continuous and rapid.
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> The efficiency of the regulations and of the methods employed under them is demonstrated by the fact that for two years there has not been a case of the

disease outside of the very restricted areas on the Atlantic seaboard which have from the first been recognized as infected. These regulations are still in force, and with the almost complete eradication of the contagion the danger of any infection extending to other sections has practically disappeared.

In 1891 the disease had disappeared from all of the States that had been infected except New Jersey, where it was restricted to a very small area, enabling the Bureau to publish the statement that "the United States is now practically free from contagious pleuro-pneumonia." On March 25, 1892, the last case of the disease disappeared from the United States, and six months later the following proclamation was issued:

PROCLAMATION—ERADICATION OF PLEURO-PNEUMONIA.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY.

To all whom it may concern:

Notice is hereby given that the quarantines heretofore existing in the counties of Kings and Queens, State of New York, and the counties of Essex and Hudson, State of New Jersey, for the suppression of contagious pleuro-pneumonia among cattle, are this day removed.

The removal of the aforesaid quarantines completes the dissolving of all quarantines established by this Department in the several sections of the United States for the suppression of the above-named disease.

No case of this disease has occurred in the State of Illinois since December 29, 1887, a period of more than four years and eight months.

No case has occurred in the State of Pennsylvania since September 29, 1888, a period of four years, within a few days.

No case has occurred in the State of Maryland since September 18, 1889, a period of three years.

No case has occurred in the State of New York since April 30, 1891, a period of more than one year and four months.

No case has occurred in the State of New Jersey since March 25, 1892, a period of six months, and no case has occurred in any other portion of the United States within the past five years.

I do therefore hereby officially declare that the United States is free from the disease known as contagious pleuro-pneumonia.

J. M. RUSK, *Secretary.*

Done at the city of Washington, D. C., this 26th day of September, A. D. 1892.

It may be that those countries which are still afflicted with the plague of contagious pleuro-pneumonia are in position better to appreciate the importance of the work done in this country than we are ourselves. If the Bureau of Animal Industry, by eradicating this disease from the country, were to be given credit for the value of all losses which would have resulted from a continuance of the disease, as well as for the money which might have been expended ineffectually by the State authorities toward suppressing it, who can estimate what it would be?

In a summary of the work of the Bureau, published in 1897, the chief wrote as follows regarding the eradication of contagious pleuro-pneumonia:

It is almost impossible at this time to give an idea of the danger with which the cattle industry was menaced by the spread of that fatal and treacherous disease to a point so far in the interior as Chicago or of the difficulties under our form of Government of promptly and effectually meeting the emergency. Fortunately, although the cattle owners in the affected districts were not friendly, the State authorities cooperated in every case and supplied the power which was lacking in federal legislation, and although there were many who questioned the existence of the European lung plague in this country, who did not believe in the success of the measures that were adopted, who were positive that the disease could not be eradicated, or who were certain that untold millions of money would be squandered before the end was reached, the result was accomplished with an expenditure of less than five years of time and of $1,500,000—a sum which is less than 5 per cent of the value of the beef exported in 1892.

When we consider that the Governments of Great Britain, France, and Germany all undertook the work of eradicating pleuro-pneumonia long before the establishment of our Bureau of Animal Industry, and that none of them have yet succeeded in freeing their territory from the plague, we can appreciate the fact that the completion of our task in a comparatively short time was a notable achievement.

In order to make this review of the pleuro-pneumonia work complete and satisfactory, the following tables, taken from the report of the Bureau for 1892, are given:

Work done in the eradication of pleuro-pneumonia, by years.

ILLINOIS.

Character of work.	September 1, 1886, to December 3, 1887.	1888.	Total.
Herds inspected	7,411	140	7,551
Cattle inspected	24,059	285	24,344
Post-mortem examinations	7,267	1,712	8,979
Number diseased on post-mortem	350	4	354
Premises disinfected	677	1	678
Diseased cattle purchased	172	4	176
Exposed cattle purchased	870	129	999

MARYLAND.

Character of work.	1887.	1888.	1889.	1890.	Total.
Herds inspected	5,704	9,809	10,904	4,210	30,627
Cattle inspected	57,868	60,312	79,606	108,376	306,162
Cattle tagged	....	17,749	10,534	5,463	33,746
Post-mortem examinations	2,788	5,820	11,491	12,949	33,048
Number diseased on post-mortem	1,137	507	76	....	1,720
Premises disinfected	145	145	35	1	326
Diseased cattle purchased	*a* 1,442	459	73	....	1,974
Exposed cattle purchased	*a* 1,564	1,036	310	20	2,930

a Includes all purchases of cattle from July 1, 1886, to December 31, 1886.

Work done in the eradication of pleuro-pneumonia, by years—Continued.

NEW YORK.

Character of work.	1887.	1888.	1889.	1890.	1891.	*a* 1892.	Total.
Herds inspected	1,511	12,333	15,861	19,569	13,381	2,537	65,192
Cattle inspected	25,122	99,726	149,396	150,474	136,111	49,925	610,754
Cattle tagged	....	100,370	33,135	33,752	30,294	13,558	211,109
Post-mortem examinations	1,347	15,538	15,375	18,338	26,953	18,871	96,422
Number diseased on post-mortem	447	2,287	1,012	544	31	....	4,321
Premises disinfected	....	1,339	339	434	49	....	2,161
Diseased cattle purchased	266	1,576	1,053	427	25	....	3,347
Exposed cattle purchased	736	3,196	2,819	1,984	284	....	9,019

NEW JERSEY.

Character of work.	1887.	1888.	1889.	1890.	1891.	*a* 1892.	Total.
Herds inspected	1,428	8,018	8,455	8,492	8,124	16,813	51,330
Cattle inspected	16,461	72,095	76,001	60,659	68,262	128,017	421,495
Cattle tagged	....	13,318	11,672	8,817	12,818	22,153	68,778
Post-mortem examinations	248	6,846	14,242	9,419	4,417	5,562	40,734
Number diseased on post-mortem	113	514	189	43	63	32	954
Premises disinfected	....	275	208	104	57	196	840
Diseased cattle purchased	94	502	116	44	48	40	844
Exposed cattle purchased	117	945	714	242	227	222	2,467

PENNSYLVANIA.

Character of work.	1888.	1889.	1890.	1891.	*a* 1892.	Total.
Herds inspected	5,291	1,311	1,915	1,096	2,638	12,251
Cattle inspected	72,565	24,603	24,388	55,533	66,487	242,976
Cattle tagged	51,820	1,513	....	....	....	53,333
Post-mortem examinations	13,157	13,412	15,008	55,260	80,384	177,221
Number diseased on post-mortem	72	17	....	....	....	89
Premises disinfected	117	6	....	....	....	123
Diseased cattle purchased	63	....	....	....	....	63
Exposed cattle purchased	131	11	....	....	....	142

SUMMARY.

Character of work.	Illinois.	Maryland.	New York.	New Jersey.	Pennsylvania.	Total.
Total herds inspected	7,551	30,627	65,192	51,330	12,251	166,951
Total cattle inspected	24,341	306,152	610,754	421,495	242,976	1,605,721
Total cattle tagged	....	33,746	211,109	68,778	53,333	366,966
Total post-mortem examinations	8,979	33,048	96,422	40,734	177,221	356,404
Total diseased on post-mortem	354	1,720	4,321	954	89	7,438
Total premises disinfected	678	326	2,161	840	123	4,128
Total diseased cattle purchased	176	1,974	3,347	844	63	*b* 6,404
Total exposed cattle purchased	999	2,930	9,019	2,467	142	*c* 15,557

a The figures for 1892 are brought down to September 26, the date on which the quarantine was removed.

b Not including 45 diseased animals purchased in Virginia and District of Columbia.

c Not including 57 exposed animals purchased in Virginia and District of Columbia.

Expenditures in the eradication of pleuro-pneumonia from July 1, 1886, to September 1, 1892.

State.	Salaries.	Traveling.	Miscellaneous.	Affected cattle.	Exposed cattle.	Total.	Number of animals affected.	Number of animals exposed.
New York	$385,672.70	$58,013 29	$28,897.52	$87,241.69	$198,669.80	$758,495.00	3,347	9,019
New Jersey	185,533.92	44,018.03	12,956.79	20,477.50	60,967.70	323,953.94	844	2,467
Pennsylvania	40,201.36	4,462.44	2,614.66	1,243.50	3,357.50	51,879.44	63	142
Maryland	124,948.22	33,705.74	5,667.42	48,363.41	76,115.85	288,800.64	1,974	2,930
Illinois	52,170.31	3,819.29	4,126.61	3,260.80	16,561.64	79,938.65	176	999
Vermont,[1] Massachusetts,[1] Virginia, and District of Columbia	3,342.28	1,177.72	19.55	739.00	754.50	6,033.05	45	57
Total	791,868.79	145,196.51	54,282.55	161,325.90	356,426.99	1,509,100.72	6,449	15,614

[1] Investigating reported outbreaks.

TEXAS FEVER WORK.[1]

The direct losses to the cattle industry of the country from Texas fever at the time when the Bureau of Animal Industry was organized were much heavier than the losses from pleuro-pneumonia. Texas fever had been known under different names for many years, and had become thoroughly disseminated and established throughout the Southern portion of the United States. Although the true nature of the disease was not known, investigations had developed several important facts, namely, that Southern cattle, when taken to the North, though in the best of health, would carry with them the contagion; that Northern cattle, when taken to the South, would contract the disease; that there was, therefore, an infected and a noninfected area, between which it was necessary to draw a definite line; and that "even a fence was sufficient to arrest the disease."

If the cattle raisers of the noninfected region were to be protected from Texas fever, and if those of the infected area were to be permitted to ship their stock out of it, it was necessary that measures should be first adopted to control the transportation. Such measures were alike important in the South, where animals were imported from the North for the purpose of grading up the herds, and in the North, where Southern cattle were to find feed for fattening and a market. The noninfected area of the country was rapidly increasing its production of corn, and needed the feeders from the infected area to consume it.

When the Bureau of Animal Industry was established, it was recognized as one of its most important duties that the Texas fever

[1] Synonyms: Southern fever, splenetic fever, splenic fever, Spanish fever, acclimation fever, acclimatization fever, tick fever.

district must be accurately outlined, and that there must be laws absolutely preventing the driving of cattle from the infected to the noninfected sections, except during certain winter months. Previous to this, in 1883, the chief of the Bureau and his assistants had established the northern line of this district through Virginia. In 1884 the Bureau extended the line westward to the Mississippi River, and in the following year it reached the Rio Grande in Texas. Later it became necessary to include a part of California.

REGULATIONS REGARDING TEXAS FEVER.

Regulations were issued by Secretary Rusk in 1889, addressed to the managers and agents of railroad and transportation companies in the United States, directing their attention to the area infected with Texas fever and to the quarantine line thereby established. These regulations have been modified from time to time as necessities have arisen; and in order to a satisfactory understanding of all the details of the work the regulations promulgated for the year 1899 are given below in their entirety. The quarantine line mentioned has since been amended by special orders, excluding on account of local cooperation the noninfected districts of some of the States, but in all essential points it is the same as originally defined:

To managers and agents of railroads and transportation companies of the United States, stockmen, and others:

In accordance with section 7 of the act of Congress approved May 29, 1884, entitled "An act for the establishment of a Bureau of Animal Industry, to prevent the exportation of diseased cattle, and to provide means for the suppression and extirpation of pleuro-pneumonia and other contagious diseases among domestic animals," and of the act of Congress approved March 22, 1898, making appropriation for the Department of Agriculture for the fiscal year ending June 30, 1899, you are hereby notified that a contagious and infectious disease known as splenetic, or Southern, fever exists among cattle in the following described area:

1. All that country lying south, or below, a line beginning at the northwest corner of the State of California; thence east, south, and southeasterly along the boundary line of said State of California to the southeastern corner of said State; thence southerly along the western boundary line of Arizona to the southwest corner of Arizona; thence along the southern boundary lines of Arizona and New Mexico to the southeastern corner of New Mexico; thence northerly along the eastern boundary of New Mexico to the southern line of the State of Colorado; thence along the southern boundary lines of Colorado and Kansas to the southeastern corner of Kansas; thence southerly along the western boundary line of Missouri to the southwestern corner of Missouri; thence easterly along the southern boundary line of Missouri to the western boundary line of Dunklin County; thence southerly along the said western boundary to the southwestern corner of Dunklin County; thence easterly along the southern boundary line of Missouri to the Mississippi River; thence northerly along the Mississippi River to the northern boundary line of Tennessee at the northwest corner of Lake County; thence easterly along said boundary line to the northeast corner of Henry County; thence in a northerly direction along the boundary of Tennessee to the northwest corner of Stewart County; thence in an easterly direction along the northern boundary of Tennessee to the southwestern corner of Virginia; thence northeasterly along

the western boundary line of Virginia to the northernmost point of Virginia; thence southerly along the eastern boundary line of Virginia to the northeast corner of Virginia where it joins the southeastern corner of Maryland, at the Atlantic Ocean.

2. Whenever any State or Territory located above or below said quarantine line, as above designated, shall duly establish a different quarantine line, and obtain the necessary legislation to enforce said last-mentioned line strictly and completely within the boundaries of said State or Territory, and said last above-mentioned line and the measures taken to enforce it are satisfactory to the Secretary of Agriculture, he may, by a special order, temporarily adopt said State or Territorial line.

Said adoption will apply only to that portion of said line specified, and may cease at any time the Secretary may deem it best for the interest involved, and in no instance shall said modification exist longer than the period specified in said special order; and at the expiration of such time said quarantine line shall revert without further order to the line first above described.

Whenever any State or Territory shall establish a quarantine line for above purposes, differently located from the above-described line, and shall obtain by legislation the necessary laws to enforce the same completely and strictly, and shall desire a modification of the federal quarantine line to agree with such State or Territorial line, the proper authorities of such State or Territory shall forward to the Secretary of Agriculture a true map or description of such line and a copy of the laws for enforcement of same, duly authenticated and certified.

3. From the 1st day of January, 1899, no cattle are to be transported from said area south or below said federal quarantine line above described to any portion of the United States above, north, east, or west of the above-described line, except as hereinafter provided.

4. Cattle from said area may be transported, by rail or boat, for immediate slaughter, and when so transported the following regulations must be observed:

(*a*) When any cattle in course of transportation from said area are unloaded above, north, east, or west of this line to be fed or watered, the places where said cattle are to be fed or watered shall be set apart, and no other cattle shall be admitted thereto.

(*b*) On unloading said cattle at their points of destination, pens, sufficiently isolated, shall be set apart to receive them, and no other cattle shall be admitted to said pens; and the regulations relating to the movement of cattle from said area, prescribed by the cattle sanitary officers of the State where unloaded, shall be carefully observed. The cars or boats that have carried said stock shall be cleansed and disinfected as soon as possible after unloading and before they are again used to transport, store, or shelter animals or merchandise.

(*c*) All cars carrying cattle from said area shall bear placards, to be affixed by the railroad company hauling the same, stating that said cars contain Southern cattle, and each of the waybills or bills of lading of said shipment by cars or boats shall have a note upon its face with a similar statement. Whenever any cattle have come from said area and shall be reshipped from any point at which they have been unloaded to other points of destination, the cars carrying said animals shall bear similar placards with like statements, and the waybills or bills of lading be so stamped. At whatever point these cattle are unloaded they must be placed in separate pens, to which no other cattle shall be admitted.

(*d*) No boat having on board cattle from said district shall receive on board cattle from outside of said district. Cattle from said district shall not be received on board when destined to points outside of said district where proper facilities have not been provided for transferring the said cattle from the landing to the stock yards and slaughterhouses without passing over public highways, unless permission for such passing is first obtained from the local authorities.

(*e*) The cars and boats used to transport such animals, the chutes, alleyways, and pens used during transportation, and at points of destination, shall be disinfected in the following manner:

Remove all litter and manure. This litter and manure may be disinfected by mixing it with lime or saturating it with a 5 per cent solution of 100 per cent carbolic acid; or, if not disinfected, it may be stored where no cattle can come into contact with it during the period from February 1 to November 15 of each year.

Wash the cars and the feeding and watering troughs with water until clean.

Saturate the entire interior surface of the cars and the fencing, troughs, and chutes of the pens with a mixture made of 1½ pounds of lime and one-quarter pound 100 per cent straw-colored carbolic acid to each gallon of water; or a solution made by dissolving 4 ounces of chloride of lime to each gallon of water may be used; or disinfect the cars with a jet of steam under a pressure of not less than 50 pounds to the square inch.

5. Cattle originating in said area may, after having been properly dipped, under the supervision of an inspector of this Department, be shipped without further restriction, excepting such as may be enforced by local authorities at point of destination: *Provided*, That application be first made to this Department, and permission granted to establish the dipping stations, and that after being dipped the cattle are certified by an inspector of the U. S. Bureau of Animal Industry, and that the cattle when dipped be shipped in clean cars, and not be driven through the infected district or unloaded therein except at such point as may be duly designated by an order issued by this Department.

6. From November 1 to December 31, inclusive, cattle from said area which are found free of infection upon inspection by officers of this Department may be moved north of the quarantine line without restriction other than may be enforced by local regulations at destination. If evidence of infection is found upon such inspection, the cattle must be dipped in accordance with the provisions of section 5 before being moved north of the quarantine line.

7. Cattle from the Republic of Mexico may be admitted into the United States, after inspection according to law, as follows:

(*a*) Cattle free from splenetic, or Texas, fever, and from contact therewith during the three months preceding such inspection, and which have been grazed in a locality free from infection of such fever, may be admitted into any part of the United States. If destined to points in the noninfected area, a special permit must be obtained from an inspector of the Bureau of Animal Industry, said permit being issued according to the regulations of said Bureau; the cattle for which said permit is issued must not be driven through the infected area, nor be unloaded in any part thereof except at such point as may be duly designated by an order issued by this Department; if shipped in infected cars, or unloaded in the infected area, except as above stated, they will be subject to the regulations concerning infectious cattle.

(*b*) Cattle found upon inspection to be infected or to have been exposed to infection during the preceding three months must be dipped at port of entry under supervision of an inspector of this Department prior to admittance to the United States; after dipping said cattle shall be subject to the conditions specified in the last preceding paragraph.

8. Notice is hereby given that cattle infested with the *Boophilus bovis*, or Southern cattle tick, disseminate the contagion of splenetic, or Southern, fever (Texas fever): therefore cattle originating outside of the district described by this order, or amendments thereof, and which are infested with the *Boophilus bovis* ticks shall be considered as infectious cattle and shall be subject to the rules and regulations governing the movement of Southern cattle.

9. Stock-yard companies receiving cattle infested with said ticks shall place such cattle in the pens set aside for the use of Southern cattle, and transportation

companies are required to clean and disinfect all cars and boats which have contained the same, according to the requirements of this Department.

10. Inspectors are instructed to see that disinfection is properly done, and to report instances of improper disinfection. It is expected that transportation and stock-yard companies will promptly put into operation the above methods.

All prior orders conflicting herewith are hereby revoked.

JAMES WILSON, *Secretary.*

It will be observed that section 5 of the regulations relates to the dipping of the cattle for the purpose of killing the tick, which is the carrier of the contagion. The Bureau has been experimenting along this line for several years, but, while progress has been made, a mixture has not yet been found which will kill the ticks and at the same time result in no injury to the animal. The end sought is so desirable that the Bureau will continue its work in the belief that a substance will be found which will prove entirely satisfactory.

The beneficial effect of such regulations was apparent from the first. Export cattle were protected from infection, and consequently losses from disease in transit were fewer each year. In 1891 such losses of export cattle from Texas fever amounted to 524 head, but fell to the number of 131 the following year, and since that there have been but two or three cases, and these at rare intervals. The result has been increased prices abroad and a great reduction of insurance on cargoes of cattle, as will be noted further on.

SHEEP SCAB AND HOG CHOLERA WORK.

In December, 1895, the regulations of the Bureau of Animal Industry were amended to the extent that "animals affected with hog cholera, tuberculosis, or sheep scab shall be considered animals affected with contagious or infectious diseases, * * * and shall not enter into interstate trade nor be brought into contact with other animals intended for such trade." Such animals are not permitted to enter any stock yards or other places where animals are handled for interstate trade, and when so found are condemned, tagged, and placed in quarantine. Stock-yard companies, transportation companies, and other parties receiving or handling such diseased animals are required to disinfect thoroughly such parts of their premises or property as contained such animals, subject to the approval of the inspectors of the Bureau. Animals so quarantined can not be removed except upon written permit of the inspector in charge. General instructions were given to the inspectors by the chief of the Bureau soon after the above-mentioned regulations were made, in which it was provided that sheep affected with scab might be liberated after being dipped one or more times and the inspectors convinced that the disease was cured.

Scab is one of the oldest diseases of sheep known to the veterinary profession, and while it is easily cured and methods for its eradication are well known, it has been permitted to spread among flocks, to the great damage of the sheep industry of the country. The efforts which the Bureau had so far been able to make were not sufficient to control the spread of the disease. It became necessary in 1897 to issue an order to managers and agents of railroads, transportation companies, and stockmen, calling their attention to the fact that it was unlawful to transport diseased sheep from one State to another, and requesting their cooperation to prevent the further spread of the disease. Inspectors were instructed to see that all cars, boats, or other vehicles of transportation were properly cleaned and disinfected by their owners.

As the facilities of the Bureau have increased, the sheep traffic has received more attention and the restrictions have become more rigid. The question of dips had to receive consideration, as some of the dips on the market were not satisfactory, in that they did not kill the mite which is the cause of the scab. In consequence of this fact the following order was issued in July, 1899:

It is ordered, That from and after August 10, 1899, no sheep affected with scabies, and no sheep which have been in contact with others so affected, shall be allowed shipment from one State or Territory into another, or from any State into the District of Columbia, or from the District into any State, unless said sheep shall have first been dipped in a mixture approved by this Department.

The dips now approved are:

1. The tobacco-and-sulphur dip, made with sufficient extract of tobacco to give a mixture containing not less than five one-hundredths of 1 per cent of nicotine and 2 per cent flowers of sulphur.

2. The lime-and-sulphur dip, made with 8 pounds of unslaked lime and 24 pounds of flowers of sulphur to 100 gallons of water. The lime and sulphur should be boiled together for not less than two hours, and all sediment allowed to subside before the liquid is placed in the dipping vat.

The owner of the sheep is privileged to choose which one of the above-mentioned dips shall be used for his animals. The Department will instruct inspectors to enforce due care in dipping sheep, but it assumes no responsibility for loss or damage to such animals, and persons who wish to avoid any risks that may be incident to dipping at the stock yards should see that their sheep are free from disease before they are shipped to market.

In the matter of hog cholera and swine plague, the administrative work of the Bureau is under the same law as that for sheep scab. In addition to the methods of quarantine and disinfection, however, hogs are being given the serum treatment for these diseases. The serum for this work is prepared by the Bureau, and at present is administered for experimental purposes by the Bureau officials. During the last two years the work has been undertaken on a large scale in Page County, Iowa, by the legislative consent of that State, and the results have been very satisfactory. It is estimated that the saving in the treated herds has been from 75 to 80 per cent.

The "stamping-out" process, the same that was so successfully employed in the eradication of pleuro-pneumonia, was tried experimentally in eight townships of the same county in 1897, and the results indicated that if the method were vigorously pursued for a few years the disease could thus be greatly reduced or possibly eradicated. A recapitulation of the work in 1897, giving also a comparison with the same period for 1896, shows wonderful success, especially if it be remembered that the disease in Page County was of long standing, and that therefore most farms were affected with the contagion:

Number of outbreaks in 1896 (six months)	218
Number of outbreaks in 1897 (six months)	80
Difference	138
Number of head lost in 1896 (six months)	12,849
Number of head lost in 1897 (six months)	1,111
Difference	11,738

These figures show that 138 fewer premises were affected and 11,738 fewer hogs died in the season of 1897, while the "stamping-out" methods were enforced, than for the same period in 1896. The total cost of this work, which included remuneration for slaughtered animals, was $10,157.12. It is assumed that if the average weight of the 11,738 hogs was 100 pounds, and their value 3 cents per pound, the saving to the eight townships under consideration was $35,214, a sum very much greater than the total expenses. It is true that the eradication of these diseases from a State by the "stamping-out" process would occasion the expenditure of a vast sum of money, and would cause more or less inconvenience and arouse some opposition. This plan has not been pursued, because the serum treatment promised equally good results without the slaughter of all animals in an infected herd, and consequently at comparatively slight expense, thus avoiding the inconvenience and irritation which invariably follow the more arbitrary measures.

BLACKLEG WORK.

When the Bureau of Animal Industry undertook to investigate the prevalence of blackleg in the United States it was merely known that the disease existed in certain districts. From its recent investigations, it is "apparent that the loss from blackleg in certain portions of several States exceeds that from all other causes combined."[1] While this disease is infectious, it has not been considered necessary to quarantine it at any time. The results of investigations of the Bureau indicate very decidedly that the disease may be eradicated by inoculation and proper disinfection of premises.

At the beginning of this work the Bureau saw the necessity for a "single" vaccine, that is, a vaccine which when used once would

[1] Dr. V. A. Nörgaard, Fifteenth Annual Report of the Bureau of Animal Industry.

produce the same immunity as is produced by two vaccinations, or with a "double" vaccine. The use of the double vaccine involved the treatment of each animal twice, with an interval of ten days between the two inoculations. This work, when considered in connection with the large herds of the West, where it is necessary to each operation that the cattle be "rounded up" from a large section of country, oftentimes scores of miles in extent, involves much inconvenience and expense, and it never became popular with the cattle raisers. In July, 1896, Dr. V. A. Nörgaard, then a veterinary inspector for the Bureau, after having made an investigation, and appreciating all the objections to the double vaccine, stated that it was "desirable that some vaccine which will produce immunity after one inoculation be introduced in this country." Accordingly, experiments were begun in the fall of 1896 for the purpose of preparing such a vaccine. Hundreds of thousands of doses have been mailed to cattle owners, who are enabled, by following the directions accompanying the vaccine, to inject it themselves without the aid of a veterinarian. Each person who receives the vaccine is requested to answer a series of questions after the season closes, in order that an estimate of the results of the work may be made.

In 1898 the total number of reports received from the States and Territories where the disease was most prevalent (namely, in Texas, Nebraska, Kansas, Colorado, Oklahoma, Indian Territory, North Dakota, and South Dakota) was 522, covering 127,369 head of cattle. Previous to 1898 the average annual loss in the same sections was about 14 per cent. During the same season the loss previous to vaccination was 3.63 per cent and after vaccination 0.54 per cent. There were 700 deaths after vaccination, many of which, as stated by cattlemen themselves, would not have occurred if the vaccine had been injected properly. These results were so satisfactory that vaccine has been sent to all applicants since. The number of doses thus sent out during the fiscal year of 1898 exceeded 500,000.

Thus, in this brief time the Bureau of Animal Industry has made it possible to reduce the losses of cattle from blackleg to a minimum, and it is proposed to continue the manufacture and distribution of the vaccine until its efficacy is well known to the cattle owners of the country, when blackleg, it is believed, will cease to be classed among our more destructive cattle diseases.

BOVINE TUBERCULOSIS WORK.

For some time past some of the States have been making efforts toward the eradication of bovine tuberculosis by the "stamping-out" method. The work of the Bureau in this connection is confined to the rejection at stock yards and abattoirs of animals so diseased and to the manufacture and distribution of tuberculin to State authorities, by which it may be ascertained which cattle are diseased and which are not. During the last year 35,000 doses were sent out for such official use. It is not furnished for private tests.

INVESTIGATIONS OF OTHER DISEASES.

It must not be understood that the work of the Bureau has been confined to the diseases named above. The act creating the Bureau provides for the "extirpation of pleuro-pneumonia and other contagious diseases among domestic animals." All reports of outbreaks of such diseases are immediately investigated by an inspector and such action taken as is warranted in the premises.

INSPECTION OF EXPORT ANIMALS BEFORE SHIPMENT.

While the rigid inspection in connection with contagious pleuro-pneumonia and Texas fever largely reduced the number of diseased animals that was offered for export, the officials of Great Britain still insisted that cattle affected with contagious pleuro-pneumonia continued to reach their shores from the United States. In consequence of these statements, arrangements were made with the British officials to permit the presence of inspectors of the Bureau of Animal Industry at the post-mortem examinations in Great Britain of all animals supposed to be thus diseased. These inspectors commenced their work at London, Liverpool, and Glasgow on August 16, 1890, and on November 8, after post-mortem examination of 104,296 head of cattle, they reported that not one animal was found affected with the disease.

This inspection has been continued in Great Britain, but is supplemented by work under the act of August 30, 1890, which provides for the inspection before shipment of all export cattle, sheep, and hogs. This inspection at both ends of the line of shipment could not fail to be efficient. Regulations under the act mentioned were issued on October 20, 1890. The points where cattle are to be inspected are named, and the cattle passing the inspection are to be tagged and inspected again at the ports of export. Cattle arriving at the ports of export from other parts of the United States are to be inspected and tagged there. Animals are to be carried, after tagging, in thoroughly cleaned and disinfected cars. Proper notification by inspectors and shippers is required. The thoroughness of this work is such that the history of any animal tagged for export may be traced back to the farm whence it came.

Very few hogs have been exported alive. The numbers of cattle which have been inspected, tagged, and rejected in connection with this work are shown in the following table, also the inspections and exports of sheep. The number of inspections does not mean an equal number of animals, for most cattle and sheep for export are inspected twice, and so appear twice in the totals in the table.

Inspections of cattle and sheep for export, 1893–1899.

Fiscal year.	Cattle.			Sheep.	
	Number of inspections.	Number rejected.	Number tagged.	Number of inspections.	Number rejected.
1893	611,542	292	280,570		
1894	725,243	184	360,580	135,780	
1895	657,756	1,030	324,339	704,044	179
1896	815,882	1,303	377,639	733,657	893
1897	845,116	1,565	410,379	348,108	139
1898	859,346	1,438	418,694	297,719	180
1899	643,301	1,593	327,741	174,717	118

INSPECTION AND QUARANTINE OF IMPORT ANIMALS.

One of the first steps taken for the control of contagious diseases among animals was the establishment of quarantine stations at the principal Atlantic ports, where imported animals might be detained until there was no longer any danger of the development of disease from exposure to contagion in other countries. This system has been extended so as to include the frontiers bordering upon both Canada and Mexico. The stations were at first under the Treasury Department, but soon after the organization of the Bureau of Animal Industry they were transferred to its control. The wisdom of maintaining them has been attested very often. When pleuro-pneumonia was eradicated it was not permitted to enter again from Europe, where it was prevalent, and rinderpest, which almost annihilated the herds of South Africa, was not allowed to gain a foothold here. Foot-and-mouth disease had appeared several times, but was turned back through the vigilance of the Bureau inspectors.

The records kept at these quarantine stations give the date of arrivals of animals, port of shipment, name of breed, number received, and name and address of importer. Large numbers of cattle and sheep come in from Mexico and also from Canada for feeding purposes, but those landed at the Eastern seaboard are principally for breeding, and are not in large numbers.

INSPECTION OF VESSELS THAT CARRY EXPORT CATTLE.

Reference has already been made to the fact that the Texas fever regulations governing interstate transportation of live stock were so efficient as to operate to reduce the losses usually occurring among export cattle. The reduction was so marked that the chief of the Bureau was enabled to say in his report for 1890 that—

> On the whole the effect of these regulations has been extremely beneficial. As compared with former years, but a small amount of the disease has been reported either in the United States or among cattle abroad. The losses during the ocean voyage have been so much less than usual that insurance is said by shippers to have been reduced over 50 per cent. If this statement is correct, it means a saving of over a million of dollars to our shippers by this reduction of insurance alone.

There continued to be losses at sea, however, that seemed to be unnecessary, and which were due in most cases to the improper construction of the ships engaging in the trade. The ventilation was very bad, proper facilities for feeding and watering were wanting, space was badly overcrowded, the ships were sometimes unseaworthy, and the attendants were often inexperienced and worthless. While all this was bad enough, there never were such cruelties practiced as were charged in English papers and documents, inspired partly by sensationalism and partly by commercial interests. However, the defects mentioned and many other similar ones in connection with the ocean transportation of cattle were such as might easily be avoided under proper supervision. This power of supervision was given by the act of March 3, 1891, by which the Secretary of Agriculture was authorized to examine all vessels which are to carry export cattle from the ports of the United States to foreign countries, and to prescribe by rules and regulations or orders the accommodations which said vessels shall provide for export cattle "as to space, ventilation, fittings, food, and water supply, and such other requirements as he may decide to be necessary for the safe and proper transportation and humane treatment of such animals." Regulations were formulated in accordance with this act which were acceptable to the British Government. They were modified from time to time as necessities arose, until now they appear to be all that can be desired. The first result of their rigid enforcement was to drive the poorer class of ships out of the trade. Magnificent steel ships were constructed for the cattle traffic, having every convenience, with permanent fittings built into the vessels, and all the comforts and safety which ingenuity could provide. The number of inspections of vessels have averaged about 900 a year.

These regulations, supplemented by the inspection of animals in the interior of the country and their reinspection at ports of export, insure the landing of animals in Great Britain in the best possible condition. It is stated upon authority that, as a direct result of these improved conditions, the insurance rates on cattle have been reduced from $8 to less than $1 per head. A saving of $7 per head on the 397,879 exported in 1898 amounts to $2,785,153, while the expense was less than $50,000. The work should, in addition, be credited with the improved condition of live animals delivered.

It is interesting in this connection to note the percentage of losses at sea of cattle and sheep since this work was undertaken by the Bureau. The table on the next page gives the figures.

Percentages of losses of cattle and sheep at sea, 1891–1899.

Fiscal year.	Cattle.	Sheep.
1891 *a*	1.6	1.7
1892	.875	....
1893	.47	....
1894	.37	1.29
1895	.62	2.7
1896	.32	1.16
1897 *b*	.57	1.29
1898 *c*	.22	.8
1899 *d*	.31	1.54

a Includes four and one-half months of 1890.
b With animals shipped from Canada the losses were: Cattle, 1.88 per cent; sheep, 2.17 per cent.
c With animals shipped from Canada the losses were: Cattle, 0.32 per cent: sheep, 1.39 per cent.
d The loss on horses shipped was 1.11 per cent.

On account of variation in conditions and weather, a uniformly low percentage can not be maintained.

GENERAL INSPECTION OF ANIMALS AND THEIR PRODUCTS.

An act of Congress approved August 30, 1890, provided for the inspection of meats for exportation, but this was supplemented on March 3, 1891, by an act "for the inspection of live cattle, hogs, and the carcasses and products thereof which are the subjects of interstate commerce, and for other purposes." It is doubtful if Congress, in passing this law, contemplated the magnitude of the work and expense thus placed upon the Bureau of Animal Industry. The organization of a force competent to conduct a work so extensive required years of training. It was not, therefore, until 1897 that the chief of the Bureau was able to say that "during the past year all of the beef exported to Europe, and the greater part of the pork and other meat products exported, have been inspected in accordance with law."

The regulations for this inspection are most rigid, and laxity in enforcement is never permitted. The proprietors of slaughterhouses and packing houses which prepare meat for interstate or foreign commerce must apply to the Secretary of Agriculture for inspection, whereupon there is given to the establishment a number which is used by the owners of the establishment and the inspectors to mark all products issuing therefrom. An inspector of the Bureau is stationed at each establishment, and among his duties is the ante-mortem examination of all animals arriving at the stock yards which are intended for slaughter at abattoirs where the Department has established inspection. When the inspector finds an animal unfit for human food he fastens in his ear a metal tag stamped "U. S., condemned," and a serial number. These condemned animals are at once removed by the owners and disposed of in accordance with State law or municipal ordinance. Animals are condemned when found upon ante-mortem or post-mortem examination to be affected as follows: Hog cholera; swine plague; charbon, or anthrax; rabies; malignant epizootic catarrh; pyæmia and septicæmia; mange or scab in advanced stages; advanced stages of actinomycosis, or lumpy jaw; inflammation of the lungs, the intestines, or the peritoneum; Texas fever; extensive or generalized tuberculosis; advanced state of pregnancy or recent parturition; any disease or injury causing elevation of temperature or affecting the system to a degree which would make the flesh unfit for human food; immaturity, or too young to produce wholesome meat; emaciation and anæmia sufficient to render meat unwholesome; distemper, glanders, and farcy, and other malignant disorders; acute inflammatory lameness, and extensive fistula. Any organ or part of a carcass of an animal which is badly bruised or affected with tuberculosis, actinomycosis, cancer, abscess, suppurating sores, or tapeworm cyst must also be condemned.

The carcasses of animals condemned upon post-mortem examination are properly marked and then placed in a room, which is in charge of the inspector, to remain until they can be "tanked" or removed under supervision to a rendering establishment. If the owners of the carcasses do not consent to such disposition the carcasses are marked with the condemnation tag, and all express companies and common carriers are notified of the particulars and warned not to transport them out of the State. To remove a condemnation tag renders one liable to prosecution.

All carcasses leaving such establishments for local, interstate, or export trade are marked with a numbered tag or branding stamp, and a record kept in detail. Carcasses or parts of carcasses which are to be used for canning purposes are not to be tagged, but when shipped from one abattoir to another the cars carrying them are sealed and tagged on both sides. Each article of food product made from inspected carcasses, whether in cans, barrels, firkins, kits, boxes, or canvas, must bear a label giving the official number of the establishment from which the product came, and also containing the statement that it has been inspected under the law. All such packages to be shipped to any foreign country or to another State must have printed or stenciled on the side or the top the information that it is for export or for interstate trade, giving the official number of the establishment, the number of pieces or pounds, the shipping marks, and the date of the act under which inspected. The inspector then affixes the stamp of the Department of Agriculture. Certificates are issued by the inspector for all carcasses examined and for every consignment of canned meats.

The appropriation acts since 1898 carry a provision "that live horses and the carcasses and products thereof be entitled to the same inspection as other animals, carcasses, and products thereof" that are named in the acts. Only one abattoir for the slaughter of horses was in operation during the year that regulations under this provision of law have been in force. The number of horses inspected was 3,232, of which number 181 were condemned on post-mortem examination. It is required that all packages containing horse meat be so marked as to indicate the fact, and no other animals may be slaughtered at abattoirs where horses are slaughtered.

The work of general meat inspection has had a wonderful growth during the nine years of its existence. The number of animals inspected before slaughter was 3,809,459 during the fiscal year of 1892, whereas the number for the fiscal year of 1899 was 34,405,973. The number of abattoirs and packing houses in operation in 1891, when inspections were begun, was 22. It increased in 1892 to 38, and in 1899 to 138. The latter are located in forty-one cities. The following table shows the number of animals of all kinds which have been inspected before slaughter for abattoirs since the beginning of the work:

Number of animals inspected before slaughter for abattoirs having inspection, 1891–1899.

Fiscal year.	Cattle.	Calves.	Sheep.	Hogs.	Horses.	Total.
1891	83,891					83,891
1892	3,167,009	59,089	583,361			3,809,459
1893	3,922,174	92,947	870,512			4,885,633
1894	3,862,111	96,331	1,020,764	7,964,850		12,944,056
1895	3,752,111	109,941	1,341,031	13,576,917		18,783,000
1896	4,050,011	213,575	4,710,190	14,301,963		23,275,739
1897	4,289,058	259,930	5,179,643	16,813,181		26,541,812
1898	4,552,919	241,092	5,706,092	20,713,863		31,213,966
1899	4,654,842	245,859	5,718,464	23,783,576	3,232	34,405,973

While the above table shows an enormous increase in the number of animals inspected from year to year, the number of animals rejected has not increased in like proportion. This indicates that the farmers of the United States are placing upon the market a healthier lot of animals than formerly. A table showing the different species of animals rejected upon ante-mortem and post-mortem inspections for the period of 1896 to 1899, inclusive, is given herewith; the figures for previous years are not considered accurate:

Number of animals rejected upon ante-mortem and post-mortem inspections, 1896–1899.

Fiscal year.	Cattle.	Sheep.	Calves.	Hogs.
1896	31,113	17,530	3,874	97,170
1897	35,489	15,998	3,202	104,393
1898	37,613	12,902	2,850	132,741
1899	36,396	23,471	3,473	162,953

The preceding statements do not show all of the work in connection with general meat inspection. Besides animals inspected for immediate slaughter, many thousands are inspected for shipment to other cities and for miscellaneous buyers. The following table shows the magnitude of this work:

Number of animals inspected for shipment to other cities and for miscellaneous buyers, 1895–1899.

Fiscal year.	Cattle.	Sheep.	Calves.	Hogs.
1895	1,083,013	648,358	10,708	3,360,642
1896	3,479,512	1,608,094	101,271	7,452,863
1897	3,960,967	2,864,712	189,053	8,753,563
1898	4,675,318	4,322,195	227,107	10,896,812
1899	4,288,562	3,119,920	253,404	10,455,317

MICROSCOPIC INSPECTION OF PORK.

In 1881 the importation of American pork into Germany, France, and the principal countries of the continent of Europe was prohibited on the assumption that it was infested with trichinæ, and was therefore injurious to health. Although it could not be shown that American pork had caused disease, it being manifestly more wholesome than European pork, and notwithstanding the most vigorous protests by this Government, the trade was crushed and destroyed. The year before the prohibition went into effect the United States sold to France 70,000,000 pounds of pork, and to Germany 45,000,000 pounds. For ten years thereafter American pork was shut out of nearly every market of continental Europe, and the prohibition was not raised until the Bureau of Animal Industry began the microscopic inspection and certification of pork destined for those markets. The trade had to be built up anew over the prejudices that had been so firmly rooted, and it has been a slow and difficult process. Vexatious and burdensome restrictions have constantly to be met, but the trade has continued to grow notwithstanding. During the fiscal year 1892 there were 38,152,874 pounds inspected for export, 22,025,698 pounds going to countries requiring inspection and 16,127,176 to countries not requiring it, while in 1899 the total shipment was 108,928,195, of which 108,858,149 went to countries requiring inspection and 70,046 to countries not requiring it.

The regulations for this work provide that a microscopic examination be made of all hog products which are for export to countries requiring such examination. The following extract from the regulations shows the method of operation:

When the slaughtered hog is passed into the cooling room of said establishment, the inspector in charge, or his assistants, will take from each carcass three samples of muscle—one from the "pillar of the diaphragm," one from the psoas muscle, and the other from the inner aspect of the shoulder, and also from the base of the tongue when that organ is retained for exportation; and said samples will be placed in small tin boxes, and a numbered tag will be placed upon the carcass from which said samples have been taken, and a duplicate of said tag will be placed in the box with said samples. The small boxes will be placed in a large tin box provided with a lock. The boxes containing the samples from the hogs in the cooling room so tagged will be taken to the microscopist for such establishment, who shall thereupon cause a microscopic examination of the contents of each box containing samples to be made, and shall furnish a written report to the inspector, giving the result of said microscopic examination, together with the numbers of all carcasses affected with trichinæ. The samples of pork microscopically examined shall be classified as follows:

Class A.—Samples in which there are no signs of trichinæ, living or dead, calcified cysts, or other bodies or substances having any resemblance to trichinæ or trichinæ cysts.

Class B.—Samples in which there are disintegrated trichinæ or trichinæ cysts, calcified trichinæ or trichinæ cysts, or bodies having any resemblance thereto.

Class C.—Samples in which there are living or dead trichinæ bodies not disintegrated.

All carcasses coming within Class C are removed from the cooling room and disposed of by tanking, or they may be rendered into edible lard at a temperature of 150° F., or made into cooked meat products if the temperature is raised to the boiling point a sufficient time to cook thoroughly the interior of the pieces. Carcasses belonging to Class B are rejected for shipment to countries requiring inspection and certification. In all this work (the microscopic examination, the cutting up of carcasses, the marking of parts, and the keeping of records) the most careful and painstaking efforts are maintained. The result is that the pork exported to countries which require inspection is not only absolutely free from trichinæ, but has never been affected by these parasites. The amount of affected pork under Class B and Class C is less than 2 per cent of the whole amount examined microscopically.

The following table shows the amount of pork examined microscopically for export to countries requiring the inspection and to countries not requiring it for the fiscal years 1892 to 1899, inclusive:

Pork inspected microscopically for export, 1892–1899.

Fiscal year.	To countries requiring inspection.	To countries not requiring inspection.	Total.
	Pounds.	*Pounds.*	*Pounds.*
1892	22,025,698	16,127,176	38,152,874
1893	8,059,758	12,617,652	20,677,410
1894	18,845,119	16,592,818	35,437,937
1895	39,355,230	5,739,368	45,094,598
1896	21,497,321	1,403,559	22,900,880
1897	42,570,572	1,001,783	43,572,355
1898	120,110,356	161,303	120,271,659
1899	108,858,149	70,046	108,928,195

Before this work was undertaken, it was estimated that it would cost from 15 to 50 cents per carcass, but in fact the cost has been only about 6 cents per carcass. The cost per pound of the pork exported was 0.248 cent in 1894, 0.2 cent in 1895, 0.264 cent in 1896, 0.256 cent in 1897, 0.142 cent in 1898, and 0.182 cent in 1899. There were many and strong objections to the work of microscopic inspection when it was begun, but the results have been so gratifying, especially from a commercial point of view, that not only is there little criticism, but the applications for inspection are numerous. While there is room for discussion of the proposition as to whether the packer or the Government should pay the cost of the microscopic inspection, there is no longer any doubt of the wisdom of having the inspection made under the supervision of the Government.

EXPERIMENTAL EXPORTS OF DAIRY PRODUCTS.

Early in the year 1897 a series of experimental exports was begun, under the supervision of the dairy division of the Bureau of Animal Industry, by which choice butter and cheese made in the United States have been offered for sale in various foreign markets in competition with the best products of like kind from other countries. The object was to obtain information which might be of use to those wishing hereafter to sell such products in foreign markets. By practical operations under usual commercial conditions, although upon a small scale, it was possible to determine the wants of different markets, the peculiarities desirable in the products themselves or in their form of preparation, the incidental expenses, the facilities for transportation, the effects of long journeys, and the comparative merits of the dairy products of this and other countries. These experiments have been continued during the years 1897, 1898, and 1899, the shipments being made weekly most of the time and at greater intervals for a part of it.

Special agents for the Bureau of Animal Industry have visited foreign countries to investigate markets and determine where sales agencies should be established. Exports have accordingly been made to England, Germany, China, Japan, the Hawaiian Islands, Cuba, and Puerto Rico.

These trials have resulted in showing that the markets of Great Britain are by far the best for butter and cheese from the United States, if these products are to be exported. They offer the most active and continuous demand, the most discriminating judgment, and the best prices.

American cheese is the equal of any found in British markets, when it is carefully made and cured, and some lots sell at highest prices; but collectively, it now occupies a position secondary to the Canadian product, because of the patronage of the dairy industry by that Government and the official guaranty which it offers as to the purity and uniform high quality of all cheese exported from the Dominion.

PROGRESS OF PLANT BREEDING IN THE UNITED STATES.

By Herbert J. Webber and Ernst A. Bessey,
Division of Vegetable Physiology and Pathology.

INTRODUCTION.

At the beginning of the nineteenth century a few of the most advanced scientific horticulturists were commencing to recognize that plants, like animals, are capable of being improved by breeding. During the century the knowledge of the factors involved in plant breeding gradually increased and became disseminated among practical American growers. As a natural consequence of this there came to be a better understanding of the methods of plant breeding and a greater appreciation of the necessity of securing varieties adapted to local conditions, and therefore improved sorts of American origin have been gradually but surely supplanting foreign varieties.

While at the beginning of this period almost all of our cultivated fruits, cereals, vegetables, and flowers were of foreign origin, an inspection of the present trade lists shows a marked increase of native sorts and a corresponding decrease of foreign sorts. In the case of flowers, for the production of which artificial conditions largely are maintained, home-produced sorts vie in numbers with those from abroad. In cereals and vegetables a majority of the most extensively grown sorts are of American origin, and in fruits, upon which probably the most attention and skill have been brought to bear and the greatest stimulus given by well-organized societies, the native sorts have almost entirely taken the place of the foreign ones. "In the beginning of the colonization of this country," writes Bailey, "all the varieties of apples were of European origin. But in 1817, over 60 per cent of the apples recommended for cultivation here were of American origin, that is, American-grown seedlings from the original stock. At the present time [1895], fully 90 per cent of the popular apples of the Atlantic States are American productions."

The same increase of American sorts has taken place in the case of pears. As early as 1853 Hovey wrote: "It is certainly somewhat remarkable, as it is surprising, that, in the course of twenty-four years, a larger number of really fine pears have been brought to notice, of American origin, than have been introduced from Europe in the same time, or we think we might safely add, in the last fifty years." While in plums the American seedlings of the European and Japanese species rival the sorts of foreign production, the improved sorts of our native species and hybrids of these with the Japan and apricot plums are rapidly increasing and will probably soon predominate in this industry. In the cultivation of grapes, raspberries, blackberries, etc., little advance was made until our native species were taken up and improved. All of these have been profoundly modified and improved as the result of merely half a century of cultivation and breeding.

It is interesting to note that the present century has witnessed the first introduction and wonderful amelioration of some of our now most important plants. A striking instance of such a plant is the tomato, which is said to have been first brought from Santo Domingo to Philadelphia in 1798, but was not sold in the markets of that city, according to Manning, until 1829, and did not come into general use in the North until some years later. Tomatoes were introduced into Salem, Mass., by an Italian painter, Michelo Corne, in 1802; but he was said to have had difficulty in persuading the people to eat them. They were, however, used as an article of food in New Orleans in 1812. The wonderful amelioration of the tomato has thus taken place wholly within the memory of men now living, and it is not an uncommon thing to find aged people, particularly among the pioneers of the West, who remember when the tomato was cultivated as an ornamental plant, but not thought to be valuable for food. The tomato is therefore an excellent illustration of what a century of plant breeding may accomplish.

The flowers now so extensively grown were hardly known a century ago, when different varieties were just beginning to appear. The modest chrysanthemum or the carnation of that day would hardly create a sensation in our modern flower markets. The immense cut-flower trade and the hosts of elegant varieties adapted thereto are the results of less than a century of plant breeding. The greenhouse has exerted a marked influence on the plants which are thus grown, as special varieties are demanded, and the skillful cultivator breeds and selects till he secures what is desired. In all forcing-house industries special varieties adapted to this sort of culture have sprung up. The changes which have already been wrought are the wonder of naturalists and laymen alike, but the end has not yet been reached. Everything indicates increased activity in the near future. Recent developments, obtained by a few independent experimenters, have forcibly called attention to the great improvements which skill and patience may achieve in this field, and a renewed interest in such matters is very evident throughout the country.

EARLY AGRICULTURAL AND HORTICULTURAL CONDITIONS.

In the early settlement of America agriculture was limited mainly to the cultivation of such plants as were known to the settlers in their

Old World homes. Each expedition brought seeds and plants to use in starting agricultural industries, and subsequent importations of desirable varieties continued to be made; hence, the attention of the settlers was largely given to testing these experimentally to determine their usefulness. The different conditions obtaining in America from those found in Europe, from which latter place most of the introduced sorts came, rendered the outcome of the early attempts very uncertain. No exact record of the agricultural development during this period exists, but it is probable that the early introduced varieties of the various annual crops (cereals, vegetables, etc.) went through a gradual evolution and adaptation to conditions by seed selection from those plants and strains found to do the best. This selection, which the settlers almost certainly exercised, probably did not have any definite improvement or change in view other than to secure the best and most vigorous seeds. Some of our now most important agricultural crops, like corn and tobacco, are native American plants, and their main improvement consequently dates from the discovery of America. In some places, however, the Indians had developed a comparatively high state of agriculture, and many sorts of such native cultivated plants were obtained from them, as, for example, the Golden Sioux, King Philip, and Tuscarora races of field corn. An early sweet corn is also recorded as having been obtained from the Indians. According to one account it was found and introduced into Connecticut by an officer in General Sullivan's expedition against the Indians in the Genesee country in 1779. According to another account it was introduced into Massachusetts by Capt. Richard Bagnol, of Plymouth, who obtained it from the country of the Susquehanna on his return from the Sullivan expedition. The Six Nations, against which the Sullivan expedition was sent, had made considerable progress in agriculture, and are known to have cultivated large fields of corn. Besides this, they are said to have had "gardens of beans, peas, turnips, cabbages, melons, carrots, parsnips, and potatoes."

The earliest attempts at fruit growing in America were mostly failures. The varieties grown in early days were nearly all of European origin. The recorded history of American horticulture may be said not to have begun until the publication of Bernard M'Mahon's American Gardener's Calendar in 1806. At this comparatively late date native varieties had already become prominent, about 66 per cent of the 59 varieties of apples catalogued being of American origin. Even at this time, however, very great efforts were still being made to extend the range of cultivated products by introductions, the only very definite method by which the securing of new sorts was attempted. It was a costly experiment, however, and to a great extent disappointing. William Kenrick, in a letter to General Dearborn (quoted from Robert Manning), says: "From among 150 varieties imported into Boston by Eben Preble, about 1805, the only additions to the list of desirable kinds were two cherries—the Black Tartarian and White Tartarian, and a single pear."

If we had to-day only the apples and pears known at the beginning of the century, the present extensive apple culture of the prairie States and the Northwest and the pear culture of the South would be wholly impossible. American varieties, the result both of chance discoveries and of the most careful and complex methods of plant breeding, have almost entirely supplanted the introduced varieties, and are destined to become even more important. To-day we look upon plant introduction as being to a large extent a means to an end. Russian apples are being extensively introduced, not wholly with the idea that they may become important commercial sorts themselves, but that select seedlings from them and hybrids between them and native varieties may be obtained, and through these the desired hardy, cold-resistant sorts of good quality.

In the culture of strawberries, raspberries, gooseberries, grapes, etc., no material progress was made until the improvement of the native species was begun. All these fruits went through an initial stage of depending upon foreign varieties, and following this an era of improvement, during which, by careful breeding of the native species and infusion into them of the improved European blood by hybridization, strains better adapted to American conditions were obtained. This change from an almost total reliance upon introduced varieties to a marked supremacy of sorts originated here has taken place almost wholly within the past century.

EARLY METHODS OF PLANT BREEDING.

The early settlers probably practiced crude selection in growing their plants, as anyone, whatever his degree of intelligence, will unconsciously do. It is this unconscious selection of individual plants through centuries that has led to the important changes which have taken place in our principal cultivated plants. So marked has been this amelioration that in very many instances the wild forms can not now be recognized and are unknown, the most careful study of modern scientists having failed to reveal the original types.

The necessity of having varieties adapted to existing conditions was early understood, as was also the necessity of selecting the best seed. Manning, in the History of the Massachusetts Horticultural Society, says: "And in 1621 the governor requested Massasoit to exchange some of their corn, for seed, with ours, that we might judge which best agreed with the soil where we lived. The natives were acquainted with the advantage of selecting the finest ears of corn for seed, and taught the settlers to do the same. They possessed varieties adapted to the warmer or colder parts of the country."

We are inclined to think of plant breeding as based on old and well-established laws. The fact is, however, that the fundamental

TWO PROMINENT EARLY PLANT BREEDERS.

principles of intelligent plant breeding were not made known until the latter part of the eighteenth century. The sexuality of plants was not established until proved experimentally by Camerarius in 1691, and the first hybrid of which we have any record was not made until 1719, when Thomas Fairchild, an English gardener, crossed the carnation with the sweet william.

Our first exact knowledge of hybrids dates from about 1761, when Koelreuter began publishing the results of his observations. His work was entirely scientific, however, and had but little bearing on practical plant breeding, though it served to pave the way for the valuable work, soon to follow, of Thomas Andrew Knight (Pl. XXXVI), the eminent English plant physiologist. The systematic breeding of plants may be said to have begun with the work of Knight and Van Mons about the beginning of the nineteenth century. Knight was the first to show the practical value of crossing and hybridizing in the production of plant varieties. In 1806 Knight said: "New varieties of every species of fruit will generally be better obtained by introducing the farina of one variety of fruit into the blossoms of another, than by propagating any from a single kind."

Another important idea emphasized by Knight, and now quite generally accepted, is that one of the principal factors causing or inducing variation in plants is an increase of food supply or a modification thereof.

In one sense Knight may be recognized as the father of plant breeding, no other experimenter having contributed so much toward the development of the present system. Of almost equal importance, however, was the work of a contemporaneous Belgian horticulturist, Jean Baptiste Van Mons, who emphasized mainly the principle of selection. His theories were published in various papers, but mostly in his Arbres Fruitiers in 1835. His method of obtaining new varieties of fruit was to gather seeds from young trees in a state of variation, taking the fruits before they were fully ripe and allowing them to rot, with the idea that this would tend to "subdue or enfeeble" the tree, a factor which he thought to be of primary importance. These seedlings were then grown in a seed bed until they were large enough to enable him to judge of their character. He then selected the promising ones and planted them in nursery form a few feet apart, where they could be fruited on their own roots. When these selected seedlings fruited, seeds were taken from the first fruits of the most promising and sown, the same process of selection being exercised in this second generation, and so on through several or many generations of selection till success was attained. The whole process is expressed in his own words as follows: "To sow, to re-sow, to sow again, to sow perpetually, in short to do nothing but sow, is the practice to be pursued, and which can not be departed from; and in short this is the whole secret of the art I have employed."

As to the theory of selection, time has justified Van Mons's conclusions, with some modifications, but some of the ideas he advanced have been abandoned. He claimed that the older varieties of good fruit generally yield inferior seedling sorts, while new inferior varieties reproduced uninterruptedly for several generations would certainly yield good fruit. In these claims the results of recent years have shown him to have been somewhat in error. The general theory now advanced and used is to select seed for planting from the best fruits of the best tree of the best variety.

The importance of selection in improving varieties was well recognized before the publication of Van Mons's great work above referred to, and while the main credit of establishing the principle of selection is due to Van Mons, yet other independent workers accomplished nearly as important results. Bailey, in his Survival of the Unlike, called attention to the work done by Joseph Cooper, of New Jersey, in the closing years of the last century. Cooper's observations, recorded in a letter written in 1799 and published in the first volume of the Memoirs of the Philadelphia Society for Promoting Agriculture, show that he thoroughly understood the action of selection in producing changes in varieties. As an illustration, he says: "A striking instance of plants being naturalized happened by Colonel Matlack sending some watermelon seed from Georgia, which, he informed me by letter, were of superior quality. Knowing that seed from vegetables which had grown in more southern climates, required a longer summer than what grew here, I gave them the most favorable situation, and used glasses to bring them forward, yet very few ripened to perfection; but finding them to be as excellent in quality as described, I saved seed from those first ripe; and by continuing that practice four or five years, they became as early watermelons as I ever had."

It is probable that many other advanced horticulturists of that period understood and used selection in an intelligent manner. The directions given in 1822 by James Thatcher, in his American Orchardist, for the selection of seeds in attempting to produce improved sorts, would be regarded to-day as better than the recommendations given by Van Mons. "The seeds for planting," Thatcher wrote, "should always be selected from the most highly cultivated fruit, and the fairest and ripest specimen of such variety." Thatcher also described Knight's method of forcing seedlings into fruit by grafting them, and the use of hybridization in the production of varieties. It will thus be seen that even at this early date (1822) the fundamental principles of plant breeding had apparently become the common property of American agriculturists and horticulturists.

EVOLUTION OF METHODS OF PLANT BREEDING DURING THE NINETEENTH CENTURY.

It has been seen that the fundamental laws of plant breeding were fairly well understood at the beginning of the century and had come to be expounded in horticultural text-books and papers. It must be borne in mind, however, that it requires years for scientific principles to become thoroughly understood and widely disseminated, so that they form a part of common practice. The early native varieties were largely chance seedlings, and there now seem to be very many choice fruits—pears, apples, grapes, etc.—which originated in this way. However, thousands and even millions of worthless wild seedlings, of which we have no record, have grown and perished, and in reality only one here and there excels and survives.

During the first fifty years of the century almost the sole method of breeding was to select seeds from the best fruits and raise numerous seedlings, which, when they fruited, were carefully examined, and those selected for further propagation which produced desirable fruits, of better quality than the parent sorts. One of the earliest systematic attempts of this sort known to the writers is thus described in the Magazine of Horticulture of 1847: "In the fall of 1817, and in the following spring, Governor Edwards planted the seeds of pears, with the design of obtaining new and superior varieties of this fruit. In doing so, he selected the seeds of the best which could be procured, including many sorts, but the number was then very limited compared with our day." This being one of the first systematic attempts in this country to secure improved sorts, it was largely ridiculed. The results obtained, however, were of great value, as from some forty trees thus produced several fairly good sorts were secured, among them being the Calhoun, Elizabeth, Dallas, Henrietta, and Citron.

In early days, furthermore, up to the fifties, orchards were to some extent made up of ungrafted seedlings. When a particularly good fruit was produced its seeds were carefully preserved and planted, and some varieties were reproduced in the main true to seed. Immense numbers of seedling apples were thus grown, and furnished excellent opportunity for selection, but only a few produced superior fruit or new varieties. In 1845 Rev. Henry Ward Beecher wrote from Indiana to the Magazine of Horticulture: "An immense number of seedling trees are found in our State. Since the Indiana Horticultural Society began to collect specimens of these, more than 150 varieties have been sent up for inspection. * * * Of all the number presented, not six have vindicated their claims to a name or place—and not more than *three* will probably be known ten years hence."

Improvement by selection, in the strictest sense of the term, has been employed mostly with annual plants, such as wheat, corn, cotton, etc., and the methods used have been gradually perfected in different industries, until in some, as in the sea-island cotton, all growers make annual selections with the utmost care to maintain and perfect the strain they grow. Very careful methods of selection have also been devised to develop and improve corn, and many of the most productive and valuable races are the result of continuous selection through numerous generations. In such selection the greatest care is taken to secure impregnation with pollen from vigorous, productive plants. To insure this the field in which selections are being made is carefully gone over when the first silks and tassels begin to appear, and all stalks are cut out which are not vigorous and well formed and which do not show indications of being productive. By this practice it is brought about that fertilization is effected by pollen from vigorous, productive stalks only. The final selections are made in the field when the corn ripens, the seed ears being taken from the most productive and vigorous stalks that are true to the type that the breeder is selecting to establish.

In selecting wheat to improve the strain the early attempts were mainly confined to simply taking the largest grains—a practice which is now recognized as failing in the primary factor of considering the productivity and vigor of the individual plant. Many experimenters in this country have worked on the improvement of wheat by selection, but in general with rather indifferent success. Recently, however, Professor Hays, of the Minnesota Agricultural Experiment Station, has used a very careful method of selecting wheat, grown in nursery form, which has given valuable results.

Hybridization and cross-fertilization in improving plants were very little utilized in the first half of the century. Knight had started the leaven, however, and in some directions it had shown results. The idea gradually became current that there was too much chance in raising seedlings of unknown parentage. Still, as late as 1857, we find the Rural New Yorker giving the following directions in regard to raising new fruits: "Eminent pomologists disagree on this subject. Our advice, however, is to plant the best seeds of the finest varieties, take good care of the plants, and trust to Providence for the result." Considerably before this time, however, the most advanced plant breeders had given rather different directions. In 1836 A. J. Downing, one of America's best-known pomologists, wrote: "Assuming Professor Van Mons to be strictly correct, we would suggest that a great saving of time and a considerable improvement in quality and vigor, might be gained by calling in *cross fertilization* to the aid of the cultivator, as soon as the fruit of the trees (say the second generation) begins to show symptoms of amelioration. By impregnating them with the pollen of the finest varieties, we conceive that the next generation would produce excellent fruit, and at a saving of twenty or thirty years." In 1844 C. M. Hovey, one of the most successful of all American horticulturists in the production of improved sorts, said with regard to the grape: "Without stopping to institute an inquiry into the merits of his [Van Mons] theory, compared with that of artificial impregnation, as practiced by Mr. Knight and others, we shall recommend to those who would raise seedlings, the importance of commencing with the Isabella or Catawba, for one of the parents, and impregnating them with the Sweet Water, Chasselas, or some other early foreign variety. The results will be obtained in a shorter period, and, we believe, equally as favorable as by the method of successive generations alone." In 1860 Marshall P. Wilder, in his presidential address before the American Pomological Society, gave advice regarding the origination of varieties in almost exactly the same words that might be used to-day: "It was my first, so it shall be my continual and last advice;—Plant the most mature and perfect seed of the most hardy, vigorous, and valuable varieties, and, as a shorter process, ensuring more certain and happy results, cross or hybridize your best fruits."

The first record which we have been able to find of the production of a hybrid variety in America is given by Manning, in the History of the Massachusetts Horticultural Society, as follows: "Probably the first attempt in this country to produce a new fruit by cross-fertilization was by William Prince, who raised the Prince's St. Germain [pear] from seed of the old St. Germain impregnated by the White Doyenne, about 1806." One of the most successful early attempts in using hybridization was by C. M. Hovey, in the improvement of the strawberry, his first hybrid seedlings having been brought to notice in 1838. He was eminently successful in obtaining good varieties by this method, and his success led to the extensive use of hybridization in the improvement of this fruit.

In this connection, it is interesting to note that a striking success achieved by any intelligent cultivator in producing valuable varieties of any plant has often led to the general adoption of his particular methods by other breeders of the same plant. Van Mons's success in originating pears by selection led to this method being mainly used in breeding this fruit. Allen's success, in 1854, in producing a good hybrid grape doubtless stimulated the adoption of this method in preference to other methods in improving the grape.

Since the middle of the century the advance in methods of improving plants has been altogether in minor factors. The early hybridizers often used a mixture of pollen, believing that it was possible for the same seed to be influenced by pollen from several varieties, or species. The details of the process of fecundation were not well worked out at that time, and it is not surprising that early experimenters frequently erred in their conclusions and were thus led to pursue false methods. With the gradual increase in knowledge of the methods of fecundation the idea of the effectiveness of using two kinds of pollen at the same time was abandoned, and in casting about for other methods of securing the results sought growers evidently began the practical use of compound hybrids, as the method came into practice about this time. Numerous hybrid rhododendrons, begonias, etc., contain the blood of several species, mingled with the definite idea of securing in the offspring certain characteristics from each parent. Compound hybrids have been particularly valuable in grapes, among the numerous excellent sorts of such hybrids being Lady Washington, Brighton, and Brilliant.

Another important factor in the application of hybridization to securing improved strains, and one which has but very recently become prominent, is the securing of what have been termed dilute hybrids, that is, hybrids containing more blood of one variety than of the other. If in any hybrid the character of one of the parents is found to be too pronounced to give a successful combination, it is crossed with the other parent, the result being a three-fourths hybrid, that is, a hybrid deriving three-fourths of its characters from one of the original parents and one-fourth from the other.

The value of selecting distinct parents and introducing new species into combination with old ones was early recognized, but mainly among florists, where a change of color was desired. In 1836 Hovey called attention to the change in color produced in calceolarias by the introduction of a different-colored species. "It was not until the introduction of a purple species, *C. purpurea*, in 1827," writes Hovey, "that any variation took place in the color of the flowers; the previously introduced ones being yellow, of course no other shade was produced until the impregnation of the former with the latter. At the present time, however, plants are to be found of almost every tint, from the palest yellow to deep orange, and from light red to bright scarlet, as also, two or three of these shades distinct in the same flower." The results of more recent work have emphasized the importance of using very distinct parents when marked changes or new creations are desired. The improved strains of begonias and roses resulting from the introduction of *Begonia socotrana*, *Rosa rugosa*, and *R. wichuraiana*, and Burbank's walnut hybrids (crosses of *Juglans californica*, *J. regia*, and *J. nigra*) illustrate the importance of this practice. This has led in recent years to the extensive introduction of and experiments with various wild species of common cultivated plants, and the field here opened to the horticulturists and florists is one of promise.

The importance of growing hybrids through several or at least two generations, in order to secure greater variation, particularly where the hybrid is from widely distinct parents, was scientifically demonstrated by Naudin and Nägeli in 1865. The practical importance of this discovery, however, has come to be thoroughly understood and appreciated by American plant breeders only in the closing years of the century.

In very recent years there has been much discussion of the question of the improvement of certain cultivated plants by selection of the vegetative parts used in propagation. It seems to have been proved beyond question that certain plants can be greatly modified in this way, particularly as to vigor and productiveness. This method of improvement seems likely to play a very important part in the future by aiding to secure strains of standard sorts suitable for growth in special localities and varying but slightly from the original varieties.

IMPROVEMENTS EFFECTED DURING THE NINETEENTH CENTURY.

In the present paper it is possible to call attention to only a few of the most important improvements illustrative of the advances made in certain fields of agriculture and horticulture. In early days, as previously indicated, the majority of the native varieties introduced were merely chance seedlings, which grew uncared for until their good qualities were discovered, when they were brought into cultivation. The sorts obtained in this way are not primarily due to plant breeding, being simply the result of intelligent choice of chance-sown plants, yet some of these varieties have had a marked influence on the development of certain industries. Of far greater importance, however, has been the introduction of varieties which have been produced by careful methods of selection, carried through from one to many generations.

Hybridization also has already had a very marked effect in the development of many cultivated plants, and in the future it will doubtless be extensively utilized in securing desired modifications.

IMPROVEMENT IN GRAPES.

The grape has been very much improved by American cultivators and furnishes an excellent illustration of the great amelioration which may be obtained in a comparatively short period. For many years after the settlement of America the only grapes cultivated were of European origin. Numerous trials, however, proved that these were not hardy in Eastern America, and that they soon succumbed to attacks of Phylloxera and other diseases. Curiously enough the native American grapes, which were found in great abundance throughout the eastern part of the country and attracted considerable attention, were for years neglected, and it was only after the failure of the European sorts had been demonstrated that the native sorts were brought into cultivation. The first of these to attain prominence was the now famous Catawba, which was found wild in North Carolina in 1802, and was brought into general notice by Maj. John Adlum, of Georgetown, D. C. A few years later the Isabella, another wild grape, was introduced, and after the success of these two sorts had been demonstrated many other wild forms were brought into cultivation.

Apparently very little systematic effort was made to improve the grape until the appearance of Pond's Seedling in 1835. The time of its introduction is worthy of notice as being the beginning of a period of planting seeds of the native species for the purpose of making selections.

The greatest advance in grape culture in this country is without doubt due to the famous Concord, which was also produced by selection. About the year 1840, Mr. Ephraim Bull, of Concord, Mass. (Pl. XXXVI), found growing on his grounds a wild grapevine, which was apparently a seedling from some wild grapes that had been scattered about his place by boys the preceding year. He took up the vine and moved it to his garden, giving it good care until it fruited in 1843, the fruit, which was of good quality, ripening as early as the latter part of August. He was so impressed with the superior quality of this fruit and the lack of foxy flavor that "the idea at once occurred to him that another generation would be a still greater improvement." Following this out, he planted seeds of this grape, obtaining a number of seedlings. One of these, which fruited first in 1849, was so markedly superior to the others that it alone was preserved, later being named the Concord. This grape, because of its vigor, productiveness, and fine quality, at once became very popular. Not only has the variety proved of great value itself, but it has been the parent of a great number of varieties, many of them of considerable merit. Probably the best known of these are the Worden and Moore's Early. Mr. Bull continued to plant seeds of the Concord year after year until he had produced over twenty-two thousand seedlings, but of these there were only twenty-one which he recommended for cultivation, and none of them have become as popular as the parent variety.

In the last twenty years very many varieties of the grape have been produced, but no select seedlings of striking importance have appeared, the good new varieties being mainly hybrids. In this connection it is worthy of notice that the grape owes more to hybridization than does any other fruit. The Delaware grape, which is even yet a standard of excellence, is probably a natural hybrid, containing some blood of the fine European grape. This was found in a garden of foreign grapes in New Jersey about the year 1850, but received its name from Delaware, the Ohio town in which it was first brought to general notice. It is undoubtedly the best of our chance seedlings, and was the last introduced that proved of much merit.

Many of our most widely cultivated varieties of grapes, such as the Salem, Niagara, Brilliant, etc., which are common sorts in the markets, are the results of careful hybridization. The first hybrid grape produced in this country, known as Allen's Hybrid, was introduced in 1854, and was a cross of the Isabella with a European variety, supposedly Golden Chasselas. This is the epoch-making grape as far as hybrids are concerned. It was regarded with much interest because of its fine quality and appearance, and while the bright hopes regarding it were never realized, it was of the greatest importance, as it served to stimulate the improvement of grapes by hybridization. Shortly after this E. S. Rogers, of Roxbury, Mass., began introducing his new hybrid varieties, the first being sent out in 1856. His Salem is an excellent chestnut-colored sort, and is probably the most extensively grown of any hybrid grape. Rogers was closely followed by Ricketts, Burr, Caywood, Moore, Rommel, Stayman, and several others, who were very active in the production of new sorts, mainly hybrids, and more recently still, by T. V. Munson, of Denison, Tex., who has probably conducted the work on a more extensive scale than any other experimenter in this field. Munson has already sent out thirty-six new varieties, for the most part hybrids, and is still actively engaged in the work.

A tabulation of the grapes described in Bush & Son & Meissner's Grape Grower's Manual shows that, of 554 varieties described, 287 are hybrids, 141 select seedlings, 57 chance seedlings, 68 of unknown origin, and 1 a sport. Considering those of known parentage, 59 per cent are hybrids, 29 per cent select seedlings, and 12 per cent chance seedlings. These figures show the marvelous extent to which hybridization has affected the improvement of the grape.

IMPROVEMENT IN PEARS.

One of the first native varieties of pears to be introduced was the Seckel, which has remained to the present time our standard of excellence. It was found near Philadelphia during the eighteenth century, apparently being a chance seedling. Many other early native varieties introduced were obtained in this way, among them Tyson, Andrews, and the Columbia Virgoulouse, the last named remaining a popular pear for a considerable time. It was not long, however, before the practice of planting seeds of the best fruits and selecting from the resulting seedlings came to be adopted in the improvement of the pear. One of the first attempts of this kind to attract attention was that of Governor Edwards, of Connecticut, as mentioned elsewhere. Probably the most systematic and successful attempt at growing seedlings for selection was that made by Mr. Dana, of Massachusetts. He planted seeds of the best varieties and raised five or six thousand seedlings, from which he obtained many good varieties, the best being Dana's Hovey, introduced about 1860. It is worthy of note that Dana always planted the seeds of the best varieties, a practice directly opposite to Van Mons's theory, and yet succeeded in producing many good sorts.

The pear owes but little of its development to artificially produced hybrids, and yet in no other fruit have hybrids played such an important rôle. The Kieffer, Le Conte, and Garber, all widely-grown commercial pears, through which this industry has been greatly extended, are naturally-produced hybrids of the European pear and the Chinese sand pear.

The European pear, noted for its excellent quality, succeeds admirably on the Pacific coast, but has never proved wholly satisfactory in the Eastern States, and can not be successfully grown on a commercial scale south of Virginia. The Chinese sand pear comes from a region having climatic conditions very similar to those of the Eastern and Southern States, and thus finds here a congenial home. The fruit is of poor quality, however, and the variety is grown only as an ornamental tree and for stocks on which to bud other sorts. The Kieffer and Le Conte are both seedlings of the Chinese sand pear, and from their characters show that the seeds from which they grew must have been accidentally crossed with the pollen of some good variety of the European pear. It is probably to the father parent, the European pear, that is due the improved quality of the fruit, while the vigor and adaptability to growth in warm climates evidently come from the mother parent, the sand pear. These hybrid sorts practically revolutionized pear culture in the Eastern United States, extending the limit of profitable commercial pear growing several hundred miles southward. From Virginia to Florida these varieties grow luxuriantly and have practically driven out all other sorts. Even as far north as Philadelphia the Kieffer is by far the most important commercial variety.

IMPROVEMENT IN APPLES.

Among apples, as in the case of pears, the variety that is considered to be a standard of excellence, the famous Newtown Pippin, was obtained as a chance seedling. It was introduced to notice about two hundred years ago. The Baldwin apple, which has exercised such an important influence on the apple industry, was also a chance seedling, which sprang up about 1742 on the farm of Mr. John Ball, in eastern Massachusetts, and was brought into general notice by a Colonel Baldwin, from whom it took its name. This apple proved to be of such importance that its origin has recently been commemorated by the erection of a monument on the spot where the original tree stood.

Many other chance seedlings have proved to be of great value, but a large proportion of the varieties of most importance, obtained during the nineteenth century, are the results of selection either of seedlings grown for the purpose or from seedling orchards. Of these may be mentioned the Northern Spy, originated in New York about 1800; the Jonathan, introduced in 1829; the Summer Bellflower, and many others.

One of the important problems which has recently taxed the skill of apple breeders has been to secure varieties suitable for growth in the northwest prairie region. The Wealthy apple, the first variety to meet this condition, furnishes one of the most striking examples of improvement in apples effected by planting numerous seeds and selecting from the seedlings. About the year 1855 Mr. Peter M. Gideon, of Minnesota, began fruit culture, planting fruit trees of various kinds, among them thirty named varieties of apples, and also a bushel of apple seeds. Each succeeding year for nine years he planted more trees and also enough seeds to produce about a thousand trees each year, but the cold winters kept killing them off until at the end of the ten years there was left only one small seedling crab. All of Mr. Gideon's neighbors gave up the attempt to grow fruit, characterizing it as an impossibility, and urged him to do the same, but he persisted and sent to Bangor, Me., for scions and seeds. From the seeds of the Cherry Crab thus obtained one seedling proved hardy and was named the "Wealthy." Upon these varieties the apple culture of the northern Mississippi River region has been built. Within very recent years there has been great activity in hybridizing our different varieties of the apple with the varieties of Russian apples recently introduced and with the native wild crab, the object being to obtain hardier varieties. This line of experiment, started in the closing years of the century, will probably in a few years yield results of the greatest practical value.

IMPROVEMENT IN PLUMS.

For many years plum culture in America was almost entirely limited to the cultivation of introduced varieties of the European plum, but

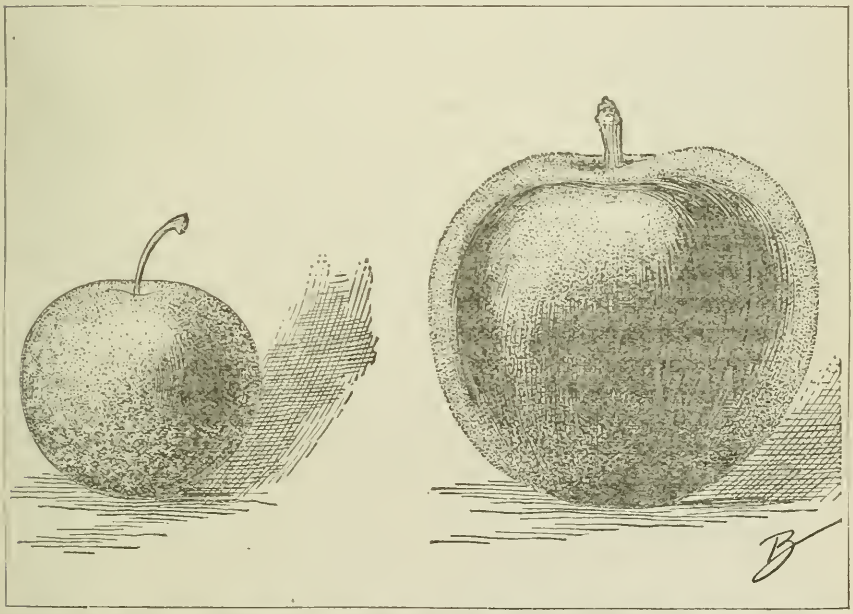

FIG. 22.—Plums showing difference between hybrid and parent: Hybrid plum Golden at right and mother parent Robinson at left, natural size (after Burbank).

little attention being given to the origination of native sorts, as, in the main, the finer foreign sorts succeed fairly well in the limited area in which the European plum can be grown. Nevertheless, some attempts were made, and in Canada Henry Corse grew thousands of seedlings for several years previous to 1840 with the hope of procuring something which would excel existing varieties. From this great number he selected several which promised well, and to four, of whose excellent quality there was no doubt, he gave the names Dictator, Victoria, Colonel Wetherell, and Nota Bena. About the middle of the century the value of our native species came to be recognized. Many selected chance seedlings were brought into cultivation, and it is to these that we owe the development of our native species of plums, nearly all the best-known varieties of which were obtained in this manner.

It is only recently that any attempt has been made to improve our plums by artificial hybridization, and this attempt has been brought about mainly by the introduction of the Japan plum (*Prunus triflora*), which has entered into most of the valuable combinations thus far produced. The first Japan plum grown in this country, the Kelsey, was not introduced until 1870. The great activity in introducing the Japanese varieties and crossing them with American sorts did not begin, however, until several years later, but, according to Professor Waugh, the Japan plum already constitutes one parent of twenty-seven hybrids which have been found valuable and named. The introduction of this plum and its use in hybridization bids fair to be of the greatest importance to the plum industry. Luther Burbank, of California, was the pioneer in plum hybridization, and has produced very many valuable sorts, such as the Golden (fig. 22), Juicy, and America (crosses of Robinson with Botan). The apricot plum, another species, has also been used a number of times by American experimenters in crossing with the Japan plum, and has yielded such fine combinations as the Climax, Chalco, Late Conical, and probably the Wickson, all of which were produced by Burbank. Some valuable hybrids of our native species have also been produced, but they are not so promising as hybrids with the Japan plums.

IMPROVEMENT IN RASPBERRIES.

The varieties of raspberries cultivated in this country are almost entirely of the native species, it having been found difficult to grow the European varieties. Accordingly, we find that our first varieties are derived mostly from wild plants picked up in the woods and the fields and brought into cultivation. Among those thus cultivated, probably the first to be named and generally distributed was the so-called English Red, which was really a native American variety. Among other chance seedlings are the Ohio Everbearing, Catawissa, and Cuthbert. The last named was found growing in a garden in Riverdale, N. Y., in the latter part of the seventies, and soon became a popular sort.

The systematic improvement of the raspberry by growing seedlings for selection was much retarded by the earlier growers of this fruit attempting to make use of the European instead of the native species.

In the meantime, however, many wild plants of the American species were domesticated on farms and in gardens. Among the early experimenters with this fruit was Dr. Brincklé, of Philadelphia, who produced a great many varieties, but only one which proved important. This was the Brincklé's Orange, produced in 1844, from an English sort known as Dyark's Seedling. It has proved to be a very popular berry, and has been widely grown, being one of the very few varieties of the European species to prove hardy in America. Soon there appeared other varieties, many of them being seedlings of foreign sorts, but probably in many cases accidentally crossed with the native species. Most of the varieties now grown, however, are improved varieties of the American species.

In the last quarter of the century several valuable hybrids have been introduced which have become popular sorts. Among these may be mentioned the Dictator (Gregg crossed with Schaffer) and the Caroline (Brincklé's Orange crossed with Black Cap).

IMPROVEMENT IN BLACKBERRIES.

The blackberry, as a cultivated plant, is entirely an American production, and we owe nothing to the European plant breeders so far as it is concerned. All the earlier varieties were merely wild plants taken up and set out in the garden. One of the first attempts to improve the blackberry was that by Mr. Lovett, of Massachusetts, who for many years attempted to find good plants and bring them into cultivation. It was not until 1850, however, that the Dorchester, the first variety to be named, was introduced. In 1854 a berry was introduced that marked an epoch in blackberry culture, and showed what the fruit was capable of becoming. This was the Lawton, or New Rochelle, as it is often called. It was found by the roadside near New Rochelle, N. Y., and was introduced by Mr. Lawton. This berry long remained popular, but its place was finally taken by Wilson's Early, also found as a wild plant.

The culture of the blackberry is still in its infancy, and comparatively little attention has been given to its improvement. Quite a number of hybrid varieties, such as Iceberg, Autumn King, Minnewaska, etc., have been introduced, but none have as yet become very well known.

The raspberry and blackberry have been repeatedly hybridized by experimenters like Burbank and Carman, and some suggestive results obtained. Burbank's series of raspberry-blackberry hybrids are in many respects the most remarkable ever produced between distinct species. The most noteworthy of these hybrids are Primus (Western dewberry crossed with Siberian raspberry), Paradox (Crystal White blackberry crossed with Schaffer raspberry), and Humboldt (Improved California Wild dewberry crossed with Cuthbert raspberry). Burbank, in speaking of the Primus, says: "It is also remarkable that the hybrid should ripen its fruit several weeks before either of the parents, and excel them much in productiveness and size of fruit, though retaining the general appearance and combined flavors of both." The Paradox was the only one retained out of some forty thousand hybrid seedlings.

IMPROVEMENT IN STRAWBERRIES.

Strawberry culture in this country was conducted on a small scale at first because no varieties well suited to the climatic conditions were known. Many were tried without success, especially the Keen's Seedling, which was represented as very promising; but while it was an exceedingly valuable berry in England, its place of origin, it failed to fulfill the expectations of those who imported it into this country. After cultivating this and many other sorts of more or less note, Mr. C. M. Hovey, an eminent American pomologist, became satisfied that there existed in this country at that time no variety possessing the qualities necessary to make its cultivation profitable. "There seemed to be wanting," says Hovey, "a variety combining the qualities of two or more of these, and we set out upon the experiment of attaining this desirable result, determined, if time would allow, to pursue it until our object was accomplished." He prepared plants of seven distinct varieties, and in 1833 made six series of crosses, having first carefully removed the stamens from the flowers to be pollinated, so as to prevent self-fertilization. The following year the resulting seeds were planted and produced plants of very varied appearance and characteristics. Only a few of these surpassed the best of the parent varieties, but one in the size and number of its berries, as well as in fine flavor, excelled anything known in this country. This plant was kept under observation six years, at the end of which period, having fulfilled the expectations of its producer, it was put on the market under the name of Hovey's Seedling (fig. 23).

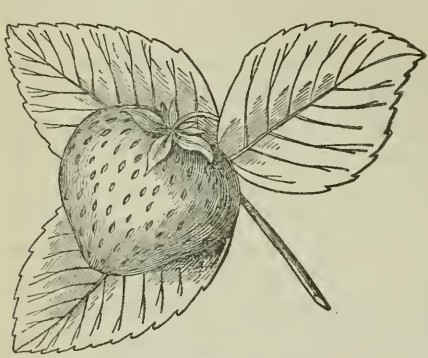

FIG. 23.—Hovey's Seedling strawberry, half natural size (from the Magazine of Horticulture).

The effect of the production of this berry was truly wonderful, and resulted in making strawberry culture popular and profitable. Other experimenters began to make crosses and to grow new sorts, but in spite of the almost innumerable varieties thus produced Hovey's Seedling remained the leading berry for almost thirty years. It is worthy of note that although it was probably the most famous variety ever produced, it is now extinct, it being impossible to obtain typical plants.

IMPROVEMENT OF THE NATIVE GOOSEBERRY: 1, RIBES OXYACANTHOIDES, WILD FORM: 2, HOUGHTON GOOSEBERRY, SEEDLING OF THE WILD FORM; 3, DOWNING GOOSEBERRY, SEEDLING OF THE HOUGHTON. (ALL NATURAL SIZE, ADAPTED FROM BAILEY.)

The Wilson, which supplanted it, is itself being gradually supplanted by other sorts, and will probably eventually disappear. Among the varieties produced from Hovey's Seedling may be mentioned Moyamensing Pine, which in 1849 was awarded the prize offered by the Philadelphia Horticultural Society for the best new berry. This was in turn the parent of many other varieties, some of which were of considerable merit.

Hybridization has been the favorite method of producing new varieties of strawberries, perhaps because the first successful variety was obtained in this way. Among the recent hybrids may be mentioned the Hunn, which also illustrates the difficulty of systematic breeding, it being the only one deemed worthy of preservation out of about seventeen hundred hybrid seedlings tested.

IMPROVEMENT IN GOOSEBERRIES.

As in the case of most other fruits, the first varieties of gooseberries grown in this country were of foreign origin. However, these mildewed very badly, especially when their cultivation became more general; hence, in the course of time the growing of this fruit was almost totally abandoned. Soon the native species began to attract attention, however, and one of the first varieties to be described was Houghton's Seedling, produced near Lynn, Mass., about 1845, from the wild gooseberry. A few years later Mr. Downing, of New York, produced from this already popular variety the Downing, a seedling which has since become extremely popular. The Houghton and Downing, compared with the wild type from which they sprang, furnish an interesting illustration of the evolution of a native wild plant. (Pl. XXXVII.) Since then a number of seedling varieties of good quality have been produced, and have come to be quite extensively cultivated. However, now that the use of fungicides has become general, the English varieties are again coming into cultivation, and it is still a question whether the advantage gained by the American varieties, owing to the exclusion of the former by mildew for so many years, will enable the American sorts to retain their supremacy.

IMPROVEMENT IN VEGETABLES.

THE TOMATO.—The tomato illustrates well what can be accomplished by careful breeding. In the early part of the century the races of tomatoes had mostly small and lobed fruits, but in the course of fifty years or more of selection the type has changed until the fruit is now large and smooth and the habit of the plant very different. As in the case of the strawberry, the first great advance in the development of the tomato in this country was made by hybridization. The Trophy tomato, introduced by the late Colonel Waring, was the first of our modern, smooth, round tomatoes, and its production and advertising, probably more than anything else, served to make the tomato a popular garden vegetable. "The Trophy tomato," in the words of Colonel Waring, "is a product of crossing and careful cultivation by Dr. Hand, of Baltimore County, Md., who began his work in connection with it about 1850. He crossed the small, smooth 'Love Apple,' which was filled with juice and seeds, with the compound, convoluted tomato of that period. This latter was practically four or five separate fruits packed together in one, with the skin running far into the convolutions. He succeeded in putting the solid mass of this compound growth into the smooth skin of the Love Apple, and then, by careful selection, year after year, increased its size and the solidity of its contents until it became a mass of flesh interspersed with small seed cells." The Trophy remained for a number of years the principal race on the market, but was finally superseded by others bearing larger and better fruits, in the production of which hybridization played an important part. The effect of selection in recent years is illustrated in the production of the Paragon by A. W. Livingston. In passing through a field of tomatoes, he selected one plant because of the uniformly smooth fruits and because of its being very prolific. The seeds from this plant were sown the next year, and the stock of seeds for planting was saved from the earliest and best specimens. By continuing this process for five years the Paragon was produced. The Acme, Perfection, and many other races were originated in a similar manner.

THE POTATO.—The potato has long been the subject of more or less systematic improvement in this country. According to Bailey, even as early as the end of the last century, Joseph Cooper made "successful experiments in keeping and improving strains of the potato." There is a record in 1835 of the production of a new variety called Perkin's Seedling, originated by planting a seed ball a year or two before. In 1841 the Pollard, a seedling of the Chenango, was introduced, but the most popular potato originated during this period was the Mercer, which was also a select seedling. For a good many years after this it was a general practice to plant potato seeds to produce new varieties, but these for the most part remained known only locally.

The introduction of new wild strains from South America marked the beginning of a very distinct epoch in the culture of the potato. About 1850, or possibly two or three years earlier, a Mr. Goodrich began experiments with a view of improving the potato, using the varieties known as the Wild Peruvian and the Rough Purple Chili, which were either direct importations from South America or but slightly improved. He grew seedlings of these varieties for fifteen years, obtaining over sixteen thousand, but considered only ten of this number worthy of cultivation. The best two of these were the Cuzco, a seedling of the Wild Peruvian, and the Garnet Chili, from the Rough Purple Chili. Later the Cuzco gave rise to several fairly valuable varieties, but it was surpassed by the Garnet Chili, from which several of our best-known varieties have been produced.

In 1860 or 1861 a grower of the Garnet Chili preserved a seed ball of this variety, pinning it up against his window until it was old and dry, when, fortunately for the potato industry of the United States, he gave it to Mr. Albert Breese, of Vermont. Mr. Breese planted the seeds and obtained widely varying plants, some producing many tubers and others but few, while there was no uniformity in their size or shape, some being large and others small, some round and others elongated. Seven of the plants proved to be of exceedingly good quality, but one of these, an early sort, far surpassed the others and was named the Early Rose. When this potato was put on the market a few years later, it commanded almost fabulous prices, and in a few years became the leading variety in America, a position which it still retains over a considerable part of the country. The other varieties of similar origin also became quite popular, and soon the old sorts were completely abandoned. In fact, there can be found in the catalogues of varieties grown at the present time scarcely a single variety popular forty years ago.

In the production of many sorts, such as the White Elephant, Snowflake, Nebula, etc., hybridization has been used, but so far none of the varieties thus produced have proved as valuable as the Early Rose.

The potato has been also somewhat improved by the selection of its tubers. Thus, when the Early Ohio was introduced, a careful selection was made of the "medium-sized, well-ripened tubers of a desired shape," with the result, according to C. L. Allen, of "fully a week's gain in earliness; a great increase in productiveness, with a marked decrease in the quantity of vines." A few of our well-known varieties originated as bud sports from the tubers; for example, Thorburn's Late Rose from tubers of the Early Rose.

THE GARDEN PEA.—The garden pea furnishes an example of great improvement produced largely by hybridization, the most marked result obtained in this country being the production of the dwarf pea American Wonder about the year 1880, up to which time the varieties grown were almost all of foreign origin. This variety was the result of a combination of McLean's Little Gem and the Champion of England. The former long stood at the head of the dwarf peas, but was unproductive; the latter at the time the cross was made was considered the best in quality and the most productive of the tall peas. The American Agriculturist says: "We look upon the production of this pea as one of the most important steps made of late in its department of horticulture."

THE SQUASH.—It is interesting to note that among squashes, which hybridize so readily, the Butman, originated by Mr. Clarendon Butman, of Maine, about 1875, was the result of crossing the Hubbard with a Japanese race and of several years of careful selection. This, according to Mr. James J. H. Gregory, was the first instance of a race of squashes produced in America, all of our standard races previous to the production of this one having been originated abroad.

IMPROVEMENT IN CEREALS.

CORN.—Corn has probably been more or less the subject of improvement by selection ever since it was first cultivated, and it is a general practice among farmers who grow their own seed to select the best ears for the next year's planting. There have been some experimenters, however, who have given special attention to its improvement, among the earliest being Mr. J. S. Leaming, who began in the early fifties by going through his fields—then producing an ordinary, not very prolific, yellow corn—and selecting seed from the best-formed plants bearing two or three well-formed ears. In this way, by a continuous selection extending over thirty years, the famous Leaming corn was produced and kept up to its standard. About fifteen years later Mr. James Riley, of Indiana, also began the careful selection of corn, taking a fine white sort as the original. He used essentially the method followed by Leaming, but in addition went through the fields just as the tassels were appearing and cut out all imperfect and barren stalks. He selected seed for the next year's planting from the finest stalks and the best and most evenly developed ears. By continuing this selection for several years he produced the Boone County White (Pl. XXXVIII, fig. 1), which has given noteworthy yields at the Illinois experiment station.

Corn has been greatly modified and improved by hybridization, but no improvement stands out as marking a distinct epoch. The earliest account of a new race being originated by hybridization which has come under the notice of the writers is that of the Smith's Early White, described in a letter by Dr. Gideon B. Smith, in the Albany Cultivator for 1838, the experiments being said to have been started some ten or twelve years earlier. It was the result of a cross between the Tuscarora and the Sioux. Dr. Smith's discussion shows that the results to be expected from crossing different races of corn were thoroughly understood even then. The original Old Colony sweet corn, a race originated about 1849, and extensively cultivated for years, was one of the first and best of the sweet-corn hybrids.

The ease with which corn hybridizes naturally in the field has led to great mixing, and doubtless many forms now cultivated are selected types of such accidental crosses. Very many of the best races, however, were originated as carefully produced hybrids.

WHEAT.—The early races of wheat grown in this country were, as was the case with almost all our cultivated plants, of foreign origin, and even now a great many sorts are being imported, especially from Russia. A large number, however, have had their origin in America,

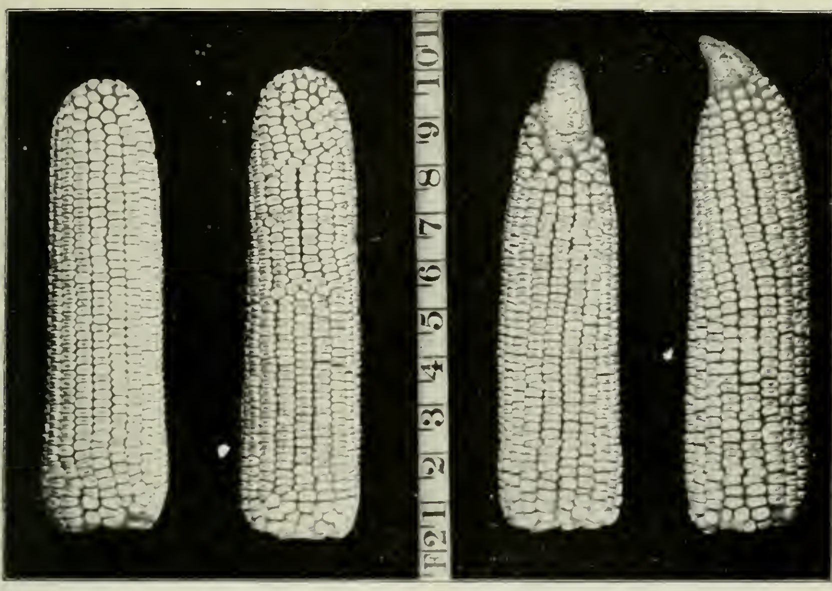

FIG. 1.—IMPROVEMENT OF CORN BY SELECTION: BOONE COUNTY WHITE CORN ON LEFT AND ORIGINAL TYPE FROM WHICH IT WAS DEVELOPED BY SELECTION ON RIGHT.

FIG. 2.—VARIATION IN SEEDLING PECANS: FROTSCHER PECAN ON LEFT AND TWO SEEDLINGS FROM IT, SHOWING VARIATIONS IN THICKNESS OF SHELL, SIZE, ETC. (NATURAL SIZE.)

the first of these being mainly such as originated in fields of wheat or from chance-sown seeds, which, owing to their differences from other wheat, were preserved and perpetuated. Such, for example, were the Tappahannock, found in Virginia in 1854, and the famous Fultz wheat, found in a field of Lancaster Red wheat in Pennsylvania in 1862 by a Mr. Abraham Fultz. Mr. Fultz was attracted by some beautiful heads of smooth wheat, which he saved and planted by themselves, and from these the new race was developed.

But little attention has been given to the systematic growing of wheat for selection until quite recently. The most important experiments of this kind in the United States are those by Prof. W. M. Hays, of the Minnesota experiment station, which are still in progress. From the year 1888 up to the present year 552 different races have been tested, from which eight were finally selected as worthy of preservation. From these eight, selection experiments were started in 1892, and as a result, even at the end of the first year, four of the best eight new strains surpassed in yield and in some other qualities the best four of the old varieties. Though it is too early yet to give more definite results, it is evident that the use of selection is very promising as regards the improvement of even the best races.

Within recent years considerable attention has also been given to hybridization, and many valuable hybrids have found places in our lists of important races. Attention has been directed mainly to increasing the yield by crossing different strains and to securing earlier and hardier sorts. Among the earlier experimenters in this field Arnold and Pringle were eminently successful. Arnold's Hybrid No. 9, a cross of Michigan Amber with White Soules, has in some places given good results. Pringle's Defiance, said to be "a hybrid of a white wheat common in California upon an Eastern club variety," has proved very valuable in California, Colorado, and other places. Prof. A. E. Blount, while at the Colorado experiment station, made many wheat hybrids and obtained several improved varieties. Blount's Hybrid No. 15, a cross of Lost Nation with Sonora, has become a well-known race, giving excellent results in some States. Probably the most valuable work in wheat hybridization in this country has been done by A. N. Jones, of New York. Mr. Jones writes: "Most of my crossbreeds are from Russian and American varieties, with some blood from Mediterranean Longberry or offspring from these combinations." Of the sixteen or more hybrid wheat races introduced by Jones, several have become standard sorts. Winter Fife, which is extensively grown in Indiana, Ohio, and other places, is probably his best-known race. His Early Red Clawson, Early Genesee Giant, etc., are among our widely grown races.

From 1888 to the present time Prof. William Saunders, director of the experimental farm, Ottawa, Canada, has been hybridizing wheats particularly to secure early ripening races. To accomplish this he has sought to secure earliness and hardiness in the best American races by hybridizing them with various Russian sorts. Preston and Stanley, derived from Ladoga, a Russian sort, crossed with Red Fife, and Alpha, Percy, and Advance, derived from Ladoga crossed with White Fife, are proving valuable additions. Tests of Preston and Advance at the Minnesota experiment station have given good results. Professor Hays, of that station, says: "Preston is the most interesting and promising variety of wheat procured outside of the State, and it bids fair to be a strong rival of our best Fife and Blue Stem wheats." Besides his important work on selection mentioned above, Professor Hays has been in recent years conducting experiments in hybridization and has obtained results of the greatest promise. It is noteworthy that in this country the wheat hybrids thus far produced which have given valuable results are racial hybrids, in many cases very complex, including several different races.

OATS.—No oat hybrids produced in this country have as yet become very important so far as the writers are informed, although some are of exceptional interest, as, for instance, Pringle's Excelsior, a so-called hull-less oat produced by crossing the common Chinese Hull-less (*Avena nuda*) with the Excelsior, a race of the common oat. This remarkable hybrid is said to possess the strength and robust character of the common oat and to retain the peculiarity of the naked seed derived from the Chinese Hull-less. It was introduced about the year 1881, but does not appear to have proved satisfactory for general culture. Recently Garton Bros., of England, have introduced a similar "naked oat," which gives great promise of proving a valuable sort, particularly for the preparation of oatmeal and similar foods. Apparently hybridization in this line promises important results.

IMPROVEMENT IN FLOWERS AND ORNAMENTAL PLANTS.

In no plants has scientific plant breeding been carried further than in those grown for their flowers or for ornamental purposes. Growers of such plants are compelled to produce new and striking varieties and races, and so must take advantage of all available methods.

An interesting example of the result of continuous selection is the Blanche Ferry sweet pea, which resulted from over twenty-five years of selection from the old Painted Lady, in northern New York. In successive years the plants gradually became more stocky and compact, until after ten or twelve years they needed no outside support. From the Blanche Ferry there have arisen independently at least two of the dwarf varieties known as "Cupids." These arose as seedling sports and soon became very widely diffused.

Probably in no other plants has hybridization given such marked results as in those cultivated for their flowers. This is due largely to the fact that in such plants variation of form and color of flowers are the greatest desiderata, and such modifications are most easily obtained by hybridizing different-colored species, varieties, etc. Orchids, roses, begonias, chrysanthemums, cannas, and many other of our common flowers have been crossed and recrossed until it is frequently impossible to determine their origin. In this country probably the most attention has been given to roses, carnations, and chrysanthemums. It is to hybridization, directly or indirectly, that we are indebted for almost all the beautiful forms of these flowers. By the introduction of foreign species and their utilization in hybridization with those already in cultivation, new and almost totally different strains are frequently produced. As an illustration of this may be mentioned the important results that have been produced by the recent introduction of the hardy roses *Rosa rugosa* and *R. wichuraiana* and their hybridization with our common varieties of roses. Manda says: "By crossing *Rosa wichuraiana* with greenhouse teas the result is astonishing, as the plants are not only hardy, but retain their foliage during the winter. Thus a new race of evergreen roses has been added to our collection, and promises to be the beginning of a new and useful class."

Advantage has been taken of still another principle in growing plants of this class. It sometimes occurs that certain buds give rise to branches that vary abnormally and produce flowers or leaves of a different color or shape from those borne on the rest of the plant. These so-called bud sports can often be perpetuated, and thus give rise to new varieties. In this way many of the cut-leaved forms of various ornamental plants have originated. Perhaps the most striking examples of the production of new sorts by bud sporting are found in certain plants, such as the chrysanthemum, rose, carnation, etc. Many of these are sports merely in color, but in some cases even the form of the flowers and of the leaves is different. It is said that within the last ten years there have been over fifty cases of new varieties of chrysanthemums originated as bud sports.

IMPROVEMENT IN NUTS.

Among the native nuts, probably the chestnut and the pecan are the only ones that have received much attention from plant breeders, though Burbank has given some care to improving the walnut. A few varieties of chestnuts have been obtained by the selection of wild trees of desirable quality, though but little more than this has been done. The pecan, however, has received more attention. In its wild state, it varies very greatly in its characteristics, and this has led to the selection of a number of varieties from wild trees because of some special quality, as thinness of shell, small amount of corky substance between the halves of the kernel, productiveness, size, or other good qualities. One of the best known of such selected pecans is the Frotscher, the original tree of which is still standing in Louisiana, and is probably over two hundred years old. Within the last fifty years many growers have been planting the nuts of this and other varieties and selecting from among the seedlings thus produced those with the best qualities. Pl. XXXVIII, fig. 2, shows the variations and the possibilities of improvement when careful selection is exercised. The systematic improvement of the pecan, however, has just begun.

IMPROVEMENT IN COTTON.

The history of sea-island cotton is extremely interesting, as it serves as an example of the possibility of adapting a tropical plant to the conditions of culture in temperate regions. About 1785 seeds of this cotton were brought to Georgia from the Bahamas. Notwithstanding the good care they received and the mild winter, the plants were killed down, but they came up again from the roots, and with this start succeeded in ripening a few seeds before the first frost in the fall. The earliest of these seeds were sown in turn, and by continuing this process of selection the flowering period became earlier and earlier, until now the plants ripen a large proportion of their seeds before frost, even along the coasts of the Carolinas. Besides striving to obtain earlier maturing sorts, very careful selection has for years been made with a view of increasing the length, fineness, and strength of the staple. This selection is regularly practiced by all intelligent growers and to-day it may be regarded as one of the necessary cultural methods. Every year a special patch of cotton is grown from selected seed; the plants in this patch are examined very carefully and the seed of the best individuals retained for planting a similar patch the next year, the seed of the remaining plants being used to plant the general crop. Under such continuous and vigorous selection the length and fineness of the fiber have gradually increased, until it is now recognized as superior to that grown anywhere else in the world and commands the highest price in the market.

DEVELOPMENT OF AGRICULTURAL LIBRARIES.

By Charles H. Greathouse, M. A.,
Editorial Clerk, Division of Publications.

A NEW FIELD FOR AGRICULTURAL LIBRARIES.

To furnish the right book to the right man at the right time is a problem that faces every student of agricultural affairs who would help men to better ways of farming. The need of offering the book at the right time presents a new opportunity for the agricultural library.

THE FARMER'S SPECIAL NEED OF BOOKS.

The production of fit books for the advancement of agriculture has long engaged the attention of promoters of scientific farming, but it is only during the last century that these books, or the information in them, have been supplied directly to the farmer. Furthermore, this supply has been thus far chiefly by books singly at home, and through the agricultural papers; and because the newspaper and the single book can not cover the whole great field of agriculture, the farmer has constantly found himself wanting information on one subject and his book or his paper offering him information on another. When cholera suddenly breaks out among his hogs, his paper has an article on sheep scab and his book deals with the diseases of the horse. His need is a library within reach that will furnish in concise form the entire body of thoroughly proved agricultural science.

Libraries have multiplied and have grown in numbers of volumes and in activity wonderfully during the past twenty-five years, and of late they have begun to come to the farmer. Granges, farmers' clubs, farmers' institutes, and farmers' reading circles have all helped to create a demand for books, and to some extent have helped to meet it. During the past ten years the traveling library movement has developed. As a result many small libraries are sent out to rural communities and are constantly exchanged among them. But these libraries are made up chiefly of "light reading," and even such as are agricultural can not be depended on to meet cases of urgent demand, because they are at one place only a few months. The establishment of permanent libraries of standard agricultural works near the farm home is a suggested need. In this direction seems to lie another step, both in library development and in the progress of scientific farming.

SCIENCE UNAVAILABLE TO FARMERS IN MOST COUNTRIES.

For centuries agricultural investigators have gathered facts by observation and experiment, and have wrought out in library and laboratory improvements in farm practice. The learning and advances of one age have been preserved in libraries for the students of the next. Libraries have had a large share in making a science of farming possible. But the great total of agricultural operatives in the world have hardly been effected by science. The facilities for producing the books necessary to teach better ways are ample, but the problem of making them available to the masses has not been solved; in most countries it has not even been approached. The bulk of agricultural products are still wrung from the soil by main strength and awkwardness. Indian ryots, Chinese coolies, and Egyptian fellaheen, comprising more than half of the agricultural labor of the world, continue to farm by traditional methods; and the peasants of Europe are little better off. The clog to their progress has not been a lack of books; it has been the lack of an elementary education; the lack not merely of a habit of reading, but of knowing how to read at all.

AMERICAN FARMERS READY FOR LIBRARIES.

But in this country the first great step has been taken; most farmers are readers. They have proved themselves capable of understanding and applying improvements in farm practice. They are the right men. It remains to put the tested and approved results of agricultural science within easy reach at the right time. In doing this, it is believed agricultural libraries may find a wide field for usefulness. An attempt will be made at the close of this paper to suggest how they may occupy it.

BEGINNINGS OF AGRICULTURAL LIBRARIES.

The founding of agricultural libraries in this country was first undertaken by the agricultural societies established in several of the States just after the close of the Revolutionary war. These organizations made part of their first work the collection of papers on farming and the publication of them first in newspapers and then in books. These papers and publications, with exchanges, and gifts of similar material from learned societies and persons, both in this country and abroad, formed the beginning of agricultural libraries. Two of these societies, the Philadelphia and the New York, besides the provision of agricultural books for themselves, projected the establishment of numerous branch libraries, and a third, the Massachusetts society, systematically promoted the founding of kindred societies similarly supplied with libraries.

WORK OF THE PHILADELPHIA SOCIETY.

The Philadelphia Society for the Promotion of Agriculture, established in 1785 at the seat of government, with Washington and

Franklin as members, in 1794 considered the founding of libraries throughout the State of Pennsylvania. This was in connection with the movement to organize a Pennsylvania agricultural society, to be made up of farmers to a much larger extent than the Philadelphia society was ever likely to be. The constitution and rules for the new society were prepared by a committee consisting of George Clymer, Timothy Pickering, then Secretary of State, John R. Bordley, and Richard Peters. One of the paragraphs was as follows:

It will also be the business of the society to recommend the collection of useful books on agriculture and rural affairs in every county. The citizens of the county should be drawn into a spirit of inquiry by the establishment of a small but well-chosen library on various subjects. This would not only promote the interests of agriculture, but it would diffuse knowledge among the people and assist good government. which is never in danger while a free people are well informed.

The country schoolmasters were to be the secretaries of the proposed branch organizations and the schoolhouses were to be the repositories of the "transactions, models, etc." But the country was not ready even for an attempt to carry out this proposal. It was years before the Pennsylvania agricultural society was established, and the schoolhouse libraries of agricultural books are still to come.

PLAN OF THE NEW YORK SOCIETY.

The New York Society for the Promotion of Agriculture and Manufactures in 1793 considered a plan, presented by Amasa Dingley, for the establishment of branch societies throughout the State. This provided for the formation of an agricultural library in connection with each society, as follows:

And also that each county society should be furnished with all the publications on agriculture in America as well as the most approved European publications. This will lay the foundation of county libraries for the promotion of information in every town and neighborhood in the whole State, and will doubtless in a few years be the means of disseminating much useful knowledge. But it is intended that each county society shall always defray its own expenses.

This plan was never realized, and there is no evidence that the parent society ever had a very large library of its own as compared with present collections. Some idea of the character of its library may be gained from the writings of Dr. Samuel Mitchill and others, as published in the society report for 1791. Among other authorities referred to are Count Ginanni of Ravenna on diseases of wheat (Delle malattie del grano in Erba in Pesaro, 1759), given by Sir Joseph Banks, president of the Royal Society of England; Chateauvieux, who describes a wheat parasite; Headrick's Essay on Manures; Summerville on Manures; Home's Principles of Agriculture and Essay on Bleaching; Swinburne's Travels into the Two Sicilies; Fourcroy's Chymistry; also, Tissot, Reaumur, Count Rumford, Lowthorp, Van Mons, Pliny, and Columella.

In closing his address to the society on January 10, 1791, Dr. Mitchill said: "My hearers have numerous volumes written within a few years on economical subjects in the different modern tongues displayed before them; or, if their classical taste should lead them to turn over the pages of the Latin authors whose works are extant, Columella and Cawley will afford them abundant pleasure, while the Georgica of Virgil and the Prædium Rusticum of Vanier shall convey most solid instruction to their minds."

LIBRARY OF THE MASSACHUSETTS SOCIETY.

The Massachusetts Society for Promoting Agriculture had something of a library in 1797. The society began the publication of agricultural notes and extracts from agricultural discussions in the Boston journals in 1793, and in 1795 printed a pamphlet containing, among other things, two premium essays on the cankerworm, a history and description of "forward wheat," a premium essay on compost, an account of maple-sugar making, and selections from foreign publications, including some account of Robert Bakewell's breeding of sheep and cattle and of the methods of making Stilton and Cheshire cheeses. Similar publications were afterwards made from year to year and distributed to societies and persons interested in agriculture. To these and the books received in return were added "the most reputable books and authoritative works on agriculture, purchased as issued." In 1815 there was published in the society quarterly, which had then been established, a list of the standard works on agriculture of that day, about 125 volumes, and it may be presumed that nearly all of them were in the society library.

THE INDIGO SOCIETY IN SOUTH CAROLINA.

In the South the only agricultural society library of this period of which notice has been found is that of the Winyah Indigo Society at Georgetown, S. C. This society was founded about the middle of the eighteenth century by well-to-do planters of that section, whose staple product was indigo. Their original purpose was discussion of public affairs and of their business interests, and in this way they probably gathered a considerable number of publications, including books on indigo culture. In 1755 they secured a charter, and in succeeding years they gathered a library of such an extent that it became well known.

AGRICULTURAL BOOKS IN COLLEGE LIBRARIES.

In the collection of agricultural works the colleges early took a leading part. Bowdoin, Harvard, Yale, Williams, Columbia, Dickinson, Princeton, the University of Pennsylvania, Brown (then the University of Rhode Island), Rutgers, William and Mary, the University of Virginia, and other schools of less prominence gathered libraries. Among the books of each of these institutions there were undoubtedly some volumes bearing on agriculture, though in some instances no record has been found to show the fact.

COLLECTION IN HARVARD LIBRARY.

The following list of books on agriculture in the Harvard library catalogue of 1790 indicates what these agricultural departments of college libraries probably amounted to. The catalogue form and punctuation are retained.

Books on agriculture, Harvard College catalogue, 1790.

Blith (Walter) English improver, or a new survey of husbandry, 4to, London. 1649.

Certain ancient tracts concerning the management of landed property. 8vo. Lond. 1767.

Columella (L. Junius Moderatus): Of husbandry, trans. into Eng., 4to, Lond. 1745.

Dossie (Rob) Memoirs of agriculture, and other economical arts. 8vo. Lond. 1768.

Du Hamel (Mons) Traité des arbres et arbustes. qui se cultivent en France, 2 tom, 4to, Paris. 1755.

——— ——— Elements of agriculture, 2 vol. 8vo, Lond. 1764.

Farmers' Letters to the people of England, 8vo, 2d ed. Lond. 1768.

Georgical Essays, 12mo, Lond. 1769.

Harte (Walter) Essays on husbandry, 8vo, Lond. 1764.

——— ——— ——— — ——— ——— 2d ed. Lond. 1770.

Home (Francis) Principles of agriculture and vegetation, 8vo, 3d ed. Lond. 1762.

Hunter (A.) Georgical Essays, 8vo., York, 1773.

Memoires concernants l'œconomie rurale, par une societé a Berne, 6 tom. 8vo., Zuric, 1760, 61, 62.

Miller (Philip) Gardner's Dictionary, fol. 7th ed. Lond. 1759.

Scriptores rei rusticæ veteres latini, a Gesnero, 4to, 2 tom. Lipsiæ. 1735.

Switzer (Stephen) Ichnographia rustica, or system of agriculture and gardening, 3 vol, 8vo, 2d ed. Lond. 1741.

Whately (Thomas) Observations on modern gardening, 8vo, Lond. 1770.

Worlidge's two treatises on husbandry, cyder and the cyder mill. 8vo, Lond. 1694.

Of 350 pages in this catalogue, 200 were devoted to theological books and pamphlets, and a large portion to law and the classic languages. It is not to be inferred, however, that this list represents all the books in Harvard library at that time that would to-day be put in the agricultural class. There were undoubtedly in the total of 12,000 volumes many treatises on botany, chemistry, entomology, and geology which were valuable to the occasional student of farm problems. They were not written, however, with any special reference to agriculture, and it was not yet common for even progressive farmers to pay much attention to any of these sciences.

AGRICULTURE IN GENERAL LIBRARIES.

In those early days agricultural books were no more numerous in general libraries than at the colleges, and were probably not as much used. Everywhere theology first by far, then law, medicine, history, travels made up the great body of the books in the libraries outside of such as were devoted to mere amusement. The volumes on agriculture in the classic tongues were about as numerous as those in modern languages, and were generally better known.

FRANKLIN'S INFLUENCE.

There was something of an exception to the theological and classical character of the early libraries in that founded by Benjamin Franklin in Philadelphia; there most of the books were devoted to the useful arts, comparatively few to the professions. One of the two volumes sent over as a present to the society by Peter Collinson, the London mercer through whom the first purchase of books was made, was Philip Miller's Gardener's Dictionary. But even in Franklin's library the books on agriculture must have been very few. One reason for this was that comparatively few of such works were in existence. In the list of approved agricultural books given by the Massachusetts Society for Promoting Agriculture in 1815 about 125 volumes were noted. This list probably included nearly all the valuable books on agriculture known in this country at that date. Now there are more printed in almost any year than the whole number then extant. In a list made up in the Office of Experiment Stations for the years 1896 to 1898, inclusive, there are 451 titles.

BOOKS ON FARMING IN THE NEW YORK SOCIETY LIBRARY.

The agricultural books in the library of the Society of New York, established in 1754, numbered about 100 at the beginning of the century. This is shown by the early catalogues. Among the titles are the following: New System of Husbandry, Varlo; Agricultural Chemistry, Davy; Husbandry of the Ancients, A. Dickson; Phytologia, E. Darwin; Horse-hoeing Husbandry, Jethro Tull; Letters to Arthur Young, Washington; American Gardener, Cobbett. There were also a full set of the Annals, Rural Economy, and other writings of Arthur Young.

AGRICULTURAL WORKS IN PRIVATE LIBRARIES.

A feature of this early period was the fact that a larger proportion of public men lived in the country and managed farms than has been the case for the past fifty years. These men often had libraries in their homes about as extensive as the college and society libraries, and they spent much time in study. The details of public affairs were not then so numerous nor the complications so intricate, and more opportunity was afforded them for reading and investigation. The greater part of library work for agriculture in those early years was undoubtedly done in the private collections of such men.

SOME OF JEFFERSON'S BOOKS.

Among the notable private libraries of the beginning of the century were those of Washington, Jefferson, Pickering, Livingston, and Mitchill. A part of Jefferson's books, including many of those which he used in his agricultural investigations, are in the Library of Congress. (Pl. XXXIX, fig. 1.) Among these are the following: Cazalet's

FIG. 1.—BOOKS OF JEFFERSON'S LIBRARY NOW IN THE LIBRARY OF CONGRESS.

FIG. 2.—LIBRARY BUILDING, AGRICULTURAL COLLEGE AND EXPERIMENT STATION, AMHERST, MASS.

Théorie de la Nature; Chaptal's Elements of Chemistry; Fourcroy's Elements d'Histoire Naturelle et de Chimie, four volumes; Ingenhousz's Expériences et Observations sur Divers Objets Physiques, and his Expériences sur les Vegetaux; Lavoisier's Traité de Chimie; Arthur Young's Six Months' Tour Through the North of England, and his Travels in France; Bibliothèque Physico-Economique, fourteen volumes; Watson's Chemical Essays, five volumes; Scheele's Memoire de Chimie; Traité Chimique de l'Air et du Feu; also a volume of agricultural essays in English and French. One of the latter is dedicated to "John Jefferson," President of the United States.

Jefferson's interest in agriculture is best known perhaps from his improvement of the plow; but, like Washington, he directed practical operations on his own estate, and his books were a constant aid to him for the purpose.

SLOW GROWTH OF AGRICULTURAL LIBRARIES.

Agricultural societies continued to be established with the development of the States, and usually gathered libraries, but none of these were of much importance. Indeed, the really efficient agricultural libraries made their appearance only when the agricultural colleges and experiment stations had attained such a growth as to make such libraries a necessity.

A good library is said to have been gathered, along with collections of material illustrative of agricultural instruction, at the Gardner Institute, founded in Maine in 1823, but Jewett's account of American libraries, written for the Smithsonian Institution in 1850, makes no mention of it. In 1839 the establishment of the division in the Patent Office for the collection and publication of agricultural statistics and the promotion of agricultural interests generally, was accompanied with the collection of agricultural works; but even here growth of the library was slow, for this Patent Office collection was turned over to the Department of Agriculture when it was founded in 1862, and with all the impetus of this new movement to promote its increase, the total number of its books in 1875, after thirty-six years of existence, was only 7,000 volumes.

AN AGRICULTURAL LIBRARY SOCIETY.

The only agricultural library society of which any record has been found was established at Amherst, Mass., about the middle of the century. A meeting of persons interested was held in Agricultural Hall in that town on January 9, 1858, and the Amherst Agricultural Library Association was organized, with a membership of eighty. Luke Sweetser was made president and Henry Holtz librarian. The books were kept in a store in Amherst. The membership fee was $3 a year, and on February 15, 1859, an assessment of 20 cents on each member had to be made to pay the debts of the association. After a few years of struggling existence the society disbanded and the books were scattered. Two volumes, Ure's Dictionary of Arts, Manufactures, and Mines, are still shown as part of the Amherst public library.

SIZE OF EARLY AGRICULTURAL LIBRARIES.

Perhaps the best evidence of the slow progress of agricultural libraries in early years is to be found in the small numbers of volumes gathered, but it must be remembered in making comparisons that no libraries were large in that day. The following list of agricultural libraries, with the numbers of volumes in each, is from the Manual of American Libraries, published by William J. Rhees in 1859: Massachusetts Board of Agriculture, including 125 books belonging to the Society for Promoting Agriculture, Boston, 1,000 volumes; Essex County Agricultural Society, Salem, Mass., 650; Michigan State Agricultural Society, Detroit, 253; Michigan State Agricultural College, Lansing, 300; Mississippi Agricultural Society, Washington, Miss., 1,000; New York Agricultural Society, Albany, 2,300; Philadelphia Horticultural Society, 1,050; Cincinnati Horticultural Society, 500; Wisconsin Agricultural Society, Madison, 300; United States Agricultural Society, Washington, D. C., 200. It is true that there are occasional omissions in this list, such as the Massachusetts Horticultural Society at Boston, with 900 volumes, but they are not sufficient to materially affect the fact that such libraries were few and small.

Even the founding of the agricultural colleges under the Morrill Act did not at once hasten the growth of agricultural libraries. This is shown by the fact that the report of the Bureau of Education on libraries, made for the Centennial Exposition in 1876, though it has a chapter on college libraries, hardly mentions one of them in its text. In its tabular statement, however, it notes libraries at agricultural colleges at the following places: Auburn, Ala., 1,720 volumes; Fayetteville, Ark., 300; Oakland, Cal., 12,000 (entire library of University of California); Irvington, Ill., 500; Urbana, Ill., 10,600 (entire library of Illinois Industrial University); Ames, Iowa, 3,540; Manhattan, Kans., 3,000; New Orleans, La., 300; Orono, Me., 2,200; College Station, Md., 1,500; Amherst, Mass., 1,500; Boston, Mass. (Bussey Institution, Harvard), 1,500; Agricultural College, Lansing, Mich., 3,700; Columbus, Ohio, 1,000; State College, Pa., 1,800; Knoxville, Tenn., 3,039; Blacksburg, Va., 600.

Agricultural libraries in this Centennial table, in addition to those just named, are as follows: Department of Agriculture, Washington, D. C., 7,000 volumes; Illinois Board of Agriculture, Springfield, 801; Massachusetts Horticultural Society, Boston, 2,800; Cambridge Horticultural Society, Cambridge, Mass., 350; Botanical Gardens, Cambridge, Mass., 2,500; Worcester County Horticultural Society, Worcester, Mass., 1,100; Sherwood Hollow Farmers' Club, Binghamton, N. Y., 1,200; Board of Agriculture, Columbus, Ohio, 1,456;

Pennsylvania Agricultural Society, Harrisburg, 2,000; Pennsylvania Horticultural Society, Philadelphia, 800; Winyah Indigo Club, Georgetown, S. C., 2,000; Agricultural Library, Montpelier, Vt., 300; Agricultural Library Association, Royalton, Vt., 350; State Agricultural Society, Madison, Wis., 1,000.

At the time of the Centennial report above referred to, general libraries had grown rapidly, keeping step with the progress of the nation. Thousands of new libraries had been founded since the beginning of the century, and marked improvement had been made in library management.

AGRICULTURAL LIBRARIES OF THE PRESENT TIME.

Agricultural libraries have now been established in connection with the agricultural colleges and experiment stations in every State and Territory in the Union. In addition to their use by students in the colleges and stations, most of these libraries are free to all who are likely to be helped. In States in which the agricultural college and the experiment station are separated there are two such libraries, one at the college and one at the station. In a majority of them the shelves are open to all readers. Farmers are especially welcome.

TYPICAL AGRICULTURAL COLLEGE LIBRARIES.

Of these college libraries, three or four will serve as typical. They show management in three ways, namely, by the principal executive officer of the school, by a board of the faculty, and by a university library board of control. In the last case the agricultural college is a department of the State university and the agricultural library a division of the university library.

Massachusetts College Library.

One of the largest of such collections is at Amherst, Mass. It has had the advantage since its establishment in 1886 of personal management by President H. H. Goodell, of the Massachusetts college and experiment station, who was at one time offered the position of librarian of Amherst College. He has, as a rule, selected the books for the agricultural library, has superintended their cataloguing and location on the shelves, and can in a few moments place his hand on almost any book in the whole collection.

This is probably the only agricultural library in the country having a house devoted exclusively to its use. The library building (Pl. XXXIX, fig. 2) is located on a low elevation near the main college building and faces east. It is of granite, and has large, handsome windows, affording ample light all through the alcoves. The minimum of space is given up to office work, and the maximum to shelving for the books and space in the alcoves for reading. The shelves are open, and any person who is allowed the privileges of the place is free to select the volume he wants, examine it on the spot and read as much as he wishes or as time will permit, and then return the book to the shelf, or take it to the assistant librarian and have a proper record made, leaving him free to take it home. The purpose has been to make as perfect a working library for agricultural students as possible with the means at command, but some agricultural books that are literary treasures have also been gathered. The chief of these are unique at once in their usefulness for study and in their position among books by reason of completeness and thoroughness of the text or by unusual illustrations.

The principal agricultural periodicals are on the table in the reading room, and files, complete and nearly complete, of the more notable of these, present and past, are on the shelves. Of the total of 19,980 volumes in this library, 3,664 titles of books, embracing 9,192 volumes, are on subjects distinctly agricultural. They are divided as follows: Agriculture, agricultural chemistry, horticulture, the domestic animals, and the dairy, 1,911 titles, 5,753 volumes; botany, 946 titles, 1,736 volumes; entomology, 564 titles, 1,211 volumes; veterinary, 243 titles, 492 volumes. Books scientific, with agricultural bearing, number 774 titles, 1,737 volumes, divided as follows: Chemistry, 326 titles, 861 volumes; geology, 110 titles, 330 volumes; meteorology, 164 titles, 251 volumes; biology, embryology, bacteriology, miscroscopy, 174 titles, 295 volumes.

Michigan College Library.

At the Michigan Agricultural College, one of the oldest of these schools in the country, and with a large number of alumni holding responsible positions in scientific agricultural work, the library appropriation was at first distributed in equal amounts to the several professors, but the library is now under the supervision of a committee composed of five members of the faculty appointed by the president of the college. All recommendations for purchases of books must be approved by this committee. The general policy tends toward a generous supply of agricultural periodicals, and from $200 to $400 a year is spent in that way. Purchases of books for the departments, as of botany, entomology, etc., are made rather cautiously, though not in a niggardly manner, with the purpose of maintaining a reserve fund from which important and expensive works can be bought when occasion offers. The library is considered especially strong in general works on agriculture and on cultivation of the soil. In this line, including horticulture, pretty much everything that is asked for is bought, though not many books in foreign languages are approved. Since 1884 a good many books on mechanical engineering have been added, and with the establishment of the woman's department, household economy has received much attention. Duplicate volumes of expensive books are sometimes bought so as to supply all members of a class.

The library now occupies the main portion of a large building, in the front of which are President Snyder's office rooms. The books belonging most closely to each branch are kept at the rooms where that study is taught, so as to be convenient as possible for students, but a report of them is made annually to the librarian. The students have access to the library alcoves during work hours, and two or three of the older students act as assistants to the librarian. The administration is thorough and businesslike. The accession book and shelf list, together with the orders for purchases and receipted bills, form a complete account of the handling of the books as they come in, and show where the volumes are to be found. These accounts are kept separately for the college and experiment station. The main floor contains the books of the college, while the station collection is in the galleries. The total number of volumes in October, 1899, was 19,380, of which about half were strictly agricultural.

Agricultural Library at Cornell.

The New York Agricultural College is a part of Cornell University at Ithaca, and the books on agriculture in the main are kept in the

FIG. 24.—Horticultural Library at Cornell (owned by Prof. L. H. Bailey).

general library. Besides those in the general library, however, the teachers of the various branches have private libraries, which are generally quite as free for proper use as the volumes belonging to the school. Since 1883 the agricultural library as part of the general library has been under the supervision of a council consisting of the president of the university, the librarian, one member of the board of trustees, and four members of the faculty.

The volumes in the library relating directly to agriculture, horticulture, and dairy husbandry number about 5,000. Aside from these there about 500 volumes on forestry, 1,200 on entomology, 1,200 on veterinary science, and a very large collection of related chemical, botanical, and other scientific literature, making in all from 15,000 to 20,000. The library is rich in serial publications. In addition to these, of special importance is the library (fig. 24) of L. H. Bailey, professor of horticulture. It is the largest collection extant of American horticultural writings, and is open to all special or advanced students in the college of agriculture. It is the general purpose to make the university library rich in foreign horticultural publications, while Professor Bailey's library provides American books of that kind.

In the teaching at this school it is the custom to take one book as the general guide in any subject, and then refer the students to many other books for special topics. In that way something like 200 volumes are much used by students in the college of agriculture. It is the purpose to give the student a thorough training in the literature of scientific farming.

Wisconsin College Library.

At the University of Wisconsin the agricultural library is in Agricultural Hall under the general library control, and numbers nearly 5,000 volumes. It is open to students and visitors between 8 a. m. and 5 p. m. Everybody has access to the books on the shelves, and anyone may take out books by obtaining a deposit card from the secretary of the board of regents. The library is used almost exclusively by the students and the faculty, but occasionally farmers and others make use of it, especially of the collection of herd and stud books, which now number 700 volumes.[1]

SOCIETY AND STATE BOARD LIBRARIES.

Agricultural libraries now found in many States consist of the collection of books belonging to agricultural and horticultural societies, breeders' associations, etc., and to State boards of agriculture. Prominent among these, are the libraries of the Massachusetts Horticultural Society and of the Massachusetts Board of Agriculture at Boston; of the Philadelphia Horticultural Society; of the New York Agricultural Society at Albany; and of the Illinois Board of Agriculture at Springfield.

Massachusetts Horticultural Society Library.

The library of the Massachusetts Horticultural Society, founded in 1829, has about 10,000 volumes. It is one of the most notable collections on horticulture in the world. It has been gathered largely by

[1] The numbers of volumes in agricultural libraries, including those of other agricultural colleges, will be found in the Appendix to this Yearbook.—Ed.

the efforts of Robert Manning, the present secretary of the society, who is also librarian. Many works in this library probably can not be found elsewhere in America. Among its treasures are the following: Martius's Flora Brasiliensis, begun in 1840 and not yet completed; Host's Gramina Austriaca, 4 volumes, with plates; Tussac's Flore des Antilles, 1808–1827; Basilius Beslerus Philiatri, 1613, the oldest edition de luxe of any botanical work in existence; The Flowers of Japan and the Art of Floral Arrangement, by Josiah Conder, professor of architecture and architect of the Imperial Japanese Government; The American Grove, the earliest botanical work published in America; Pinetum Woburnensis, published in 1839 by the Duke of Bedford, only 100 copies being printed, and the copy here costing the society about $100; Old Trees of New England, a series of photographs, with typewritten text, including pictures of the first Seckel and Bartlett pear trees in New England; Elms and Other Trees of New England, by Brooks and Dame, containing a picture of the Clark Elm, at the house where Adams and Hancock were sleeping when aroused by Paul Revere; Flora Danica, published by the Danish Government in numbers from time to time between 1764 and 1883; Pomona Italiana, by Gallesio, with illustrations unusually true to nature, cost 960 marks; Duhamel's Traité des Arbres Fruitièrs, 7 volumes, cost $500; Brooke's Gardens of England, with vignettes of palaces and colored plates of surrounding grounds. There are also very complete files of the leading horticultural periodicals of the past century and a half, including all publications edited by William Robinson, of London, and the most expensive work in the collection, Curtis's Botanical Magazine, begun in 1793, 125 volumes, with 7,691 colored plates.

The library is now crowded into the front room at the Horticultural Hall, 101 Tremont street, in the heart of the business district of Boston, but it is to have ample space in a fireproof building to be erected by the society near the Public Library and other notable public edifices at Copley Square.

The Pennsylvania Horticultural Society Library.

The Pennsylvania Horticultural Society Library, located at Horticultural Hall, Broad street, above Spruce, Philadelphia, was founded in 1827. It now has over 3,500 volumes, consisting of works on horticulture and agriculture, including all reports of the leading societies of this country. On its tables are kept regularly the leading horticultural and agricultural publications of this country, as well as some from abroad. The library is open to the public for research, but books are loaned only to members.

New York Agricultural Society Library.

The New York Agricultural Society Library was founded in 1832. In 1857 it had 2,097 volumes, and was reported as "much used." It had on its tables 76 agricultural journals, including nearly all of this country and 18 from abroad. It now has about 3,000 volumes. It is open to the public, but is "more especially for the benefit of life members of the society."

Library of the Massachusetts Board of Agriculture.

The library of the Massachusetts Board of Agriculture began to accumulate soon after the board was established in 1852. In 1857 its secretary stated in his report that it was probably "the most extensive in the United States;" in 1860 he added, "The collection of works on the honey bee is believed to be the best and most extensive in the country;" and, in 1865, "It is of great service to the public, more especially during the sessions of the legislature." The catalogue which classifies and describes the books was published in 1899. It was prepared by the librarian, Mr. F. H. Fowler. There are 3,200 volumes, many of them rare and valuable. A card catalogue is in course of preparation.

Library of the Illinois Board of Agriculture.

The library of the Illinois State Board of Agriculture was started in 1853, and there were 801 volumes in 1875. Since that date the growth has been much more rapid, and there are now 5,000 books and pamphlets, 75 per cent of which relate to agriculture and kindred industries. The library is open to the public; the live stock records are most frequently consulted.[1]

AGRICULTURAL LIBRARIES OF THE NATIONAL GOVERNMENT.

The most important agricultural libraries of this country, both from the number of books and the use made of them, are the collections of the Government, namely, the library of the Department of Agriculture, at Washington, the library of the Weather Bureau, at the central office in Washington City and at the stations throughout the country, and the agricultural books in the Library of Congress.

Library of the Department of Agriculture.

The library of the Department of Agriculture (Pl. XL) now contains 68,000 volumes, in charge of W. P. Cutter, librarian, and a corps of assistants. Of these books fully 75 per cent are strictly agricultural. Most of the remaining are historical, biographical, or such documents connected with the work of Congress or the other Departments as are likely to be frequently in demand. The purpose is to have a complete working library for the use of the various Divisions of the Department. The books are received and placed according to the methods most generally approved by leading librarians, with such modifications as adapt them to evident needs. The shelves are open to the employees of the Department, but books are to be left at the desk, to be returned to their places by the librarian's assistants.

[1] For list of agricultural libraries, including those of other boards of agriculture, see the Appendix to this Yearbook.—Ed.

LIBRARY OF THE DEPARTMENT OF AGRICULTURE (EAST HALF SHOWN).

Under proper regulations the books are also free for reference to the public generally. Volumes needed in researches which are being prosecuted in the several Divisions of the Department are taken to the Division rooms, and there remain until the work in which they are needed is completed or until an urgent call comes from some other direction. Each Division has some books which are kept constantly in its rooms. In the Bureau of Animal Industry and the Division of Statistics the numbers run into the thousands. These books are in use every day by the Department scientists and other workers, and the results of their investigations are continually issuing from the Government Printing Office in publications which are sent to investigators and libraries throughout the world and to public men and farmers in all parts of the Union. Probably nowhere in the world is an equal use made of books on agriculture.

The growth of the library on the whole has been gradual, though much accelerated in recent years and with much improved library methods. The beginning was made in 1840 with the appointment of a clerk in the Patent Office to gather agricultural statistics. When the Department of Agriculture was established in 1862 the library which had been collected in the agricultural section of the Patent Office was given to it, but some time elapsed before all the books were removed to their new quarters. Indeed, as late as 1877 the first report of the New York Society for the Promotion of Agriculture was received at the Department library from the Patent Office.

Purchases of books are made by the librarian with the approval of the Secretary. Very generally such books as are recommended by the head of a Division are procured, especially when wanted for an investigation actually in progress. Accessions in 1899 numbered about 4,000 volumes. Lists of accessions are published quarterly.

Library of the Weather Bureau.

The Weather Bureau has about 20,000 volumes. Of these 12,000 are upon meteorology and climatology, constituting one of the largest collections of the kind in the world. Possibly that of the National Library at Paris is larger. But, certainly, no other similar collection is used so directly and constantly for the advancement of agriculture. The remaining 8,000 books are chiefly upon physics, including a special collection on electricity and magnetism. There are also groups on mathematics, astronomy, and other related subjects. A few old and rare volumes are kept, but entirely for their scientific value. Such are La Place's Mécanique Céleste and Boyle's works, in handsome quarto editions. The leading periodicals on meteorology and physics are on the shelves. The accessions are about 1,000 annually, being largely exchanges from meteorological institutions throughout the world. The books are constantly in use by the scientific corps of the Bureau and are issued to employees generally, subject to recall when needed. They are free to the public for reference. The Bureau stations are all supplied with small technical libraries, while in several of the large cities, as Boston and New York, considerable collections have been made.

Agriculture in the Library of Congress.

The books on agriculture in the Library of Congress occupy a unique position. Their chief use is by Congressmen when considering legislation concerning the farming interests, and thorough work among these books for the information of a committee may lead to far-reaching and most important results. In addition to this they are free for use in the reading room. The collection fills six book stacks and numbers 10,000 volumes. It includes sets of United States and State reports of the earlier periodicals, of herdbooks and studbooks, and under the copyright law all American publications on agriculture that are protected by copyright. There are also a few notable old books on agriculture, including some in foreign languages. Besides the books classed together as agricultural there are many rare and valuable volumes in the special collections, such as the Jefferson library previously mentioned.

AGRICULTURAL BOOKS IN PUBLIC LIBRARIES.

In addition to agricultural libraries there are several hundred public libraries in the United States which have considerable collections of agricultural books. Some of these devote a dozen alcoves to this class, furnishing to the intelligent and industrious student a good opportunity to fit himself either to write upon agricultural topics or to engage actively in farming, so far at least as reading can accomplish that result.

The shelves in such libraries are not, as a rule, open to the reader. In some of them it would be of little use to him if they were; for the books are not carefully arranged according to classification. For example, in one of the great city libraries it puzzled one of the most experienced attendants to point out even the main portion of the books on agriculture. But the card catalogue affords a ready key and supplies the student in some respects more satisfactorily than he could supply himself in a thoroughly well-arranged library. There is always, of course, the drawback that it is impossible to judge of the availability of a book by reading the catalogue entry anything like as well as by a glance at it upon the shelf or by a moment's running through its pages. Among the most important of these collections in public libraries are those in Boston, New York, Chicago, and Philadelphia.

Boston Public Library.

At Copley Square, near Boylston street, in Boston, the public library offers to readers for twelve hours daily each week day and for a part of Sunday nearly 750,000 books and a very large number of newspapers and periodicals. Of these, some 20,000 are useful for reading in one branch of agriculture or another.

The reading room, thoroughly well lighted, will accommodate 310 persons, and the force of attendants is at all times sufficient to secure delivery of books in eight or ten minutes. The reader consults the card catalogue, which is kept in a separate room in a semicircular case 8 feet high, with a subtending diameter 40 feet long. The classification and cross references are so complete that hardly anything on agriculture would be overlooked.

After determining what books he wishes to consult, the reader fills out the call blanks and drops them into one of the small boxes which stand at the end of each table in the reading room. The attendants, who constantly pass along the aisle for the purpose, collect the cards and bring the books. For home use, books may be drawn, and they will be delivered at numerous branch stations.

Two New York public libraries.

The public library in New York, for which a magnificent building is under construction at Forty-second street and Fifth avenue, has about 8,000 volumes on agriculture grouped in one of the galleries and easily accessible for reference through the card catalogue. It has also an index kept up to date for its periodicals, so that anything on agriculture in current literature is at once accessible.

The Cooper Union Library has only a few hundred agricultural books, but they are recent; and probably no collection in the country is as much used by persons engaged in agriculture. The publications of the Department are received regularly and lists of them are posted.

Philadelphia Public Library.

The Philadelphia public library has some 2,500 volumes on agriculture. These are in the great Ridgway Building at Christian and Broad streets and in the main library building on the corner of Juniper and Locust streets. While the work is in the hands of a private organization, the books are practically free for reference, as in any public library. The library is well supplied with books of the earlier decades of the closing century, but little effort is made to keep up with current publications, except in landscape gardening.

Chicago Public Library.

The public library of Chicago has 7,000 volumes on agriculture and science bearing upon agriculture. These books are free to the public either for use at the library reading room or may be taken home. There are fifty-nine branch stations throughout the city at which a request may be left, and the book will be delivered at the station free. The printed finding lists issued by the library contain, in classified form, short author and title entries of all the books in the library. There is also a card catalogue giving fuller author, title, and subject entries than the finding lists. The John Crerar library also has a considerable collection of agricultural books, and, under a division of labor agreed upon with the Public and the Newberry libraries, will eventually have the agricultural library of Chicago.

COLLEGE AND SOCIETY AGRICULTURAL BOOKS.

In addition to the agricultural collections in the public libraries are the books on agriculture in society libraries and in public schools, colleges, and universities. Of these, may be mentioned several thousand volumes at Columbia University in New York, which include the most important of recent publications; also collections at Harvard, Yale, Princeton, University of Pennsylvania, University of Chicago, University of Michigan, University of Wisconsin, and the University of Indiana. In Harvard and Yale books of recent date are not found in the main library. At Harvard work on agriculture has been given over to the Bussey Institution, while at Yale the agricultural teaching has been transferred to the agricultural college at Storrs. Nevertheless, the agricultural books in the Yale collections are among the most interesting and important from the librarian's standpoint of any in the country. Most notable are books on horse breeding and horsemanship, collected by Prof. W. H. Brewer, and a complete set of the agricultural essays of Jared Eliot, published from 1748 to 1760. Among these latter is a volume of the essays published in 1760, which bears on the fly leaf Roger Sherman's autograph as a mark of ownership.

AGRICULTURAL LIBRARIES FOR FARMERS.

Farming wisely followed affords large opportunities for reading and investigation. The long winter nights by the fireside are proverbial as offering time for study. Strong inducements are now presented by granges, farmers' clubs, reading circles, and traveling libraries to spend these quiet hours in the satisfying mental exercise of reading upon the daily problems of farm life. Books for this purpose are supplied mainly by the Department of Agriculture, the agricultural colleges, and State libraries, by granges and farmers' clubs.

Reading courses with libraries.

The establishment of farmers' reading courses in Pennsylvania, New York, Connecticut, Michigan, and other States has been accompanied by the supplying of books to farmers, but in most cases these books have not been sufficient in numbers to be called libraries. In Connecticut, however, a library of fifty to one hundred volumes is furnished to clubs of ten or more farmers who have completed a prescribed two years' reading course and received a diploma. The library is kept one year by such a club and then forwarded to another recently formed club of the same kind. This plan gives a sort of post-graduate course, which promises to be very attractive to farmers actually engaged in the business, who want to farm according to scientific principles. Prof. L. H. Bailey, who started the reading courses in New York and has made a study of those of other States, said recently of this feature in Connecticut: "The reader often receives more benefit from these libraries than from the two years' preliminary reading."

In New York some of the books have been supplied for the farmers' reading clubs by writing and printing them expressly for the time and purpose. The plan of work was made with the intention of reaching farmers who were not already studying their business in books. Simple, short, and easily digested treatises were, therefore, desired, and it was found best to prepare them from the beginning. With the same purpose of spreading an interest in scientific agriculture to the most remote farming districts, societies of children called Junior Naturalist Clubs were organized. It was felt that in this, as in all instruction, the most hopeful efforts would be with the young. If the most important facts and the fundamental principles of agricultural science could be imparted to the children in rural communities generally, a wide advance in farming would be made when these children come to work the land. Here, again, leaflets and bulletins were specially prepared, and during the season of 1899–1900 great progress has been made. At the close of 1900 nearly 20,000 children were studying in this way. One of these clubs is shown by fig. 1, Pl. XLI.

Traveling libraries of agricultural books.

The traveling library movement originated in 1892 by Melvil Dewey, librarian of the New York State Library at Albany, has from the start been an especial boon to rural communities, and an effort has usually been made by the organizers in the various States where the system exists to encourage farmers to read books on farming and domestic science. But in some of the early libraries sent out to farm neighborhoods in Wisconsin, and probably in other States, there was not a single book dealing with agricultural topics. The reason was that the managers of the work believed the books must be entertaining and attractive, and this opinion was founded on experience. Now, however, in several States it is made a point to send at least one book on agriculture with every library, and many traveling libraries are made up entirely of works on farming, horticulture, and home making and keeping.

New York, through the home-education department of the University of the State of New York, offers, among fifty lists of traveling libraries, two that are made up entirely of agricultural books. One of these lists contains thirty-four volumes and the other sixty. With the smaller, some volumes on other subjects may be secured if asked for. The agricultural lists are specially recommended to farming communities. They are loaned under proper regulations to existing libraries, to granges, farmers' clubs, and similar organizations.

In Wisconsin a list of "good books for the farmer" is now sent by the State library commission to rural applicants, and offers are made to encourage the use of these books by farmers and their familes. Small pamphlets and leaflets from the Department of Agriculture and the Wisconsin bulletins have been well received, but longer and more difficult works have gone slowly.

In Connecticut a special list of works on agriculture is sent out by the State library commission and are strongly commended to libraries in rural neighborhoods.

In Illinois the traveling libraries (Pl. XLI, fig. 2) are made an adjunct of farmers' institutes. There are two branches of the library work as organized. One in charge of A. B. Hostetter, superintendent of the farmers' institutes, who has general supervision of the other branch also, provides books on crops, stock, soils, fertilizers, etc., while the other, under the management of Mrs. Joseph Carter, Mrs. Emma T. Davenport, and other women interested in farm progress, furnishes works on domestic science. The legislature in 1898–99 appropriated $15,000 for the farmers' institute, and a share of this has been set aside for the traveling libraries. The lists of books have been made up during the winter of 1899–1900, and the libraries are sent out as fast as proper attention can be given to the applications.

The Indiana traveling libraries which are sent out by the State commission offers one book on agriculture in each of the first twenty lists made up by the commissioners for general reading. There has been considerable demand from Indiana, as from other States, for publications of the Department of Agriculture to add to the agricultural books furnished by the traveling libraries.

In Iowa a movement is on foot for the creation of a library commission. In the meantime the State librarian is sending out 73 traveling libraries, mostly to rural communities. In the first 23 are 41 books on agriculture. The number will be increased as the demand warrants.

The Pennsylvania library commission, established under a law passed in 1899, will give careful attention to the claims of agricultural books to a place in its lists.

Under the Michigan law passed in 1895 the State librarian sends traveling libraries to every library in the State having over 1,000 volumes which chooses to associate itself with the State library for the purpose, and some of the books furnished are agricultural; but the chief opportunity for farmers to obtain libraries of agricultural works is in connection with the farmers' institutes, reading courses, and similar work conducted by Clinton D. Smith, director of the State experiment station.

In addition to these State-aid agricultural libraries, there is one system of traveling libraries under private management that supplies mainly agricultural reading. It is maintained by the Seaboard Air Line Railway in Virginia, the Carolinas, and Georgia, and

FIG. 1.—JUNIOR NATURALISTS' CLUB AT BERNHARDS BAY, ONEIDA LAKE, CENTRAL NEW YORK.

FIG. 2.—TRAVELING AGRICULTURAL LIBRARY USED IN CONNECTION WITH FARMERS' INSTITUTES IN ILLINOIS.

HEADQUARTERS OF TRAVELING AGRICULTURAL LIBRARIES ON THE SEABOARD RAILROAD IN VIRGINIA, THE CAROLINAS, AND GEORGIA.

managed by Mr. John T. Patrick and Mrs. E. B. Heard. Mrs. Heard's work is entirely philanthropic. The libraries (Pl. XLII) contain from 40 to 60 volumes, largely publications of the Department of Agriculture, and are sent to all important stations along the line of the railroad. After remaining thirty days at a place they are usually exchanged.

Grange libraries.

The Patrons of Husbandry throughout the United States have always, since their organization thirty years ago, systematically encouraged the establishment of libraries by the granges, as the subordinate lodges of the order are called. In all there are undoubtedly several hundred such grange libraries, but many of them have given more attention to general reading than to agricultural books. But most of them have received Yearbooks, Farmers' Bulletins, and other popular publications of the Department of Agriculture, and also the bulletins of the State experiment stations and the reports of State agricultural and horticultural societies and breeders and dairy associations. In this way they have proved effective in the promotion of scientific farming.

SUGGESTION FOR PERMANENT LIBRARIES FOR FARMERS.

The Department of Agriculture promotes and stimulates reading on agricultural topics by farmers themselves to a greater extent than any other single agency in the world. It has printed and circulated annually for the past five years on an average 6,000,000 copies of its publications. Nearly all of these have been sent to farmers directly, many of them through the instrumentality of Congressmen, to whom, under the law, two-thirds of the Farmers' Bulletins and 94 per cent of the Yearbooks are supplied for distribution among their constituents. In addition, the experiment stations in all of the States publish bulletins on their work which are valuable to the farmer directly, and these are distributed to applicants. These publications are believed to be well prepared and reliable, and can be furnished at a low cost. This suggests that permanent libraries, largely of State and United States publications, and under the joint management of the State and federal authorities, with a system of lectures on agriculture, might be made a very effective means of agricultural progress.

Such a movement would be received in a different spirit from that which met the efforts of the agricultural societies a hundred years ago. The scientific farmer is no longer ridiculed. He is observed, sometimes envied, often imitated. The problem of furnishing all farmers with the means of becoming scientific in their methods is largely the problem already suggested, of bringing the right book to the right man at the right time. A large percentage of farmers have come to know that it is possible to get help from books. The difficulty is to put the instructions that will help where the farmer can get them on the day that a puzzling question, whether of breeding or cultivation, presents itself. It does the farmer little good to receive a pamphlet covering certain information months before or after the subject has forced itself upon him. Pamphlets are to him much like newspapers—good for a day only. Also it does not meet the need for him to know that a book can be had by application to the State agricultural college or the Department of Agriculture at Washington. It will be too late when it comes, and he can not keep it till another occasion arises, a month, a year, or ten years later. He must have all the information he can carry in his head. The reading circle, farmers' institute, and traveling library will help in this. But also he must have a permanent agricultural library at the nearest practicable point. The State and national authorities may combine to furnish this, using a recent suggestion of Mr. F. A. Hutchins, of the Wisconsin library commission, that town and village libraries should be open to the support and the use of the surrounding farming communities. They might go further, and establish in every district school, under the control of the directors (trustees) and the teacher, a thoroughly good library of standard agricultural books. It would be an important part of the work of the National Government to keep these collections supplied with the results of recent discoveries, so far as available for practical application to farm operations.

Another suggestion for the location and care of such agricultural libraries is that they be put in the post office under the supervision of the postmaster. The books would then be in the hands of a federal official. The convenience of such an arrangement is manifest when it is considered that farmers could send for mail and books at the same time, and that some one capable of attending to calls would always be at hand.

AGRICULTURAL EXPERIMENT STATIONS IN THE UNITED STATES.

By A. C. True, Ph. D.,
Director of the Office of Experiment Stations.

HISTORICAL.

When the first agricultural societies were formed in this country, near the close of the eighteenth century, we find the beginnings of a recognition of the desirability of experimental inquiries for the advancement of agriculture. The society organized in South Carolina in 1785 had among its objects the establishment of an experiment farm. President Washington, who was a member of the first society for promoting agriculture organized in the United States, which was formed March 1, 1785, at Philadelphia, then the seat of the General Government, in pleading for the establishment of a national board of agriculture in his annual message to Congress in 1796, says that one of the functions of such a board is "to encourage and assist a spirit of discovery and improvement * * * by stimulating to enterprise and experiment." The distribution of seeds and plants, begun in 1839 through a Congressional appropriation secured by Hon. Henry L. Ellsworth, Commissioner of Patents, which afterwards resulted in the establishment of the Department of Agriculture, was primarily an experimental enterprise with a view to testing the adaptation of new varieties of agricultural plants to different parts of the country.

In 1849 the New York Agricultural Society established at Albany a chemical laboratory for the analysis of soils, manures, etc., and an elaborate examination of maize was made there by Dr. Salisbury. In 1855 a special agent was employed by the Patent Office "to investigate and report upon the habits of insects injurious and beneficial to vegetation, especially those infesting the cotton plant." The same office also employed a chemist and botanist, began a propagating garden, and arranged with the Smithsonian Institution for procuring and publishing records of meteorological observations. After the establishment of the Department of Agriculture in 1862, as a branch of the Government distinct from the Patent Office, the land on which its buildings now stand was for several years chiefly used as an experiment farm. As soon as agricultural colleges were established in this country experimental investigations in field and laboratory were undertaken, but for a number of years these were carried on with small means and for the most part by the voluntary labor of professors outside of their regular duties as instructors.

ESTABLISHMENT OF AGRICULTURAL COLLEGES.

The act establishing an agricultural college which was passed by the legislature of Maryland in 1856 made it a duty of the board of trustees of the institution to conduct on the college farm "a series of experiments upon the cultivation of cereal and other plants adapted to the latitude and climate of the State."

The records of the college show that in 1858, immediately after the college was located and before building began, field experiments with corn, oats, and potatoes, "to test the relative value of the different manures offered for sale in the cities of Baltimore and Washington," were commenced on the college farm. This work continued for two or three years, but was interrupted by the financial distress which soon affected the whole country and by the disturbed condition of the State and nation.

In 1870 a school of agriculture and horticulture was established in connection with Harvard College in accordance with the provisions of the will of Mr. Benjamin Bussey, of Roxbury, Mass. This school was named "The Bussey Institution." The same year Harvard College received from the Massachusetts Society for Promoting Agriculture a considerable sum "for the support of a laboratory and for experiments in agricultural chemistry to be conducted on the Bussey estate." Investigations were begun in this laboratory in 1871 by F. H. Storer, the professor of agricultural chemistry in the Bussey Institution, and his assistants, and the first report of their work was made December 3, 1871. The earliest experiments consisted of field tests of fertilizers upon the farm of the institution and chemical analyses of commercial fertilizers. A number of bulletins were published, including reports of field experiments and investigations on hybridizing plants, the composition of feeding stuffs and fertilizers, injurious fungi, and physiology. The great fire in Boston in 1872 and the commercial crisis of 1873 combined to cripple the institution financially, and for a number of years little was done in the way of original investigations. Recently, however, the financial status of the institution has improved, and investigations have been undertaken in several lines. Several bulletins have been published within the past three years, among which are those on the white pine (*Pinus strobus*), basket willow, systematic destruction of marmots and other vermin, and chemical substances in the trunks of trees. An extensive arboretum of indigenous and exotic trees, shrubs, and herbaceous plants has been developed on the grounds of the institution through a bequest made to Harvard University in 1872 by James Arnold, of New Bedford, Mass.

When the College of Agriculture of the University of California was organized it was understood that a part of its work would consist of experimental inquiries. In 1870 Prof. E. S. Carr, in an address at the State fair, stated that "the University proposes to furnish the facilities for all needful experiments; to be the station where tests can be made of whatever claims attention." The university grounds at Berkeley were developed with reference to their use for experimental purposes, and in 1874 a considerable number of varieties of grapes and orchard and small fruits were planted, and a barn and two propagating houses were built. The same year E. W. Hilgard was chosen professor of agriculture. Professor Hilgard had previously been engaged for a number of years in conducting an agricultural and geological survey in Mississippi, in connection with which chemical examinations of soils, field experiments, and other agricultural investigations had been incidentally carried on in accordance with a plan inaugurated as early as 1857 and afterwards made the basis for the highly successful work of the California experiment station, which has been continued under his direction for a quarter of a century. "In the winter of 1875–76 the first field experiments were undertaken to determine the effects of deep culture and of the application of various fertilizers. In 1875 the laboratory branch of the experiment-station work was inaugurated, the regents making provision for the expenses thereof for the first two years, and at the end of this time the legislature opened the way for the continuation and extension of the work by liberal special appropriations from year to year."

After the fund which had been established by the sale of the land scrip donated to Connecticut under the act of Congress of July 2, 1862, had been given to the Sheffield Scientific School of Yale College in 1863, a professor of agriculture was added to the working force of that institution. Samuel W. Johnson, M. A., professor of theoretical and agricultural chemistry, and William H. Brewer, Ph. D., the professor of agriculture, have for many years taken an active interest in all work for the promotion of agricultural science in Connecticut and elsewhere in the United States. Under their direction experimental work for the benefit of agriculture was carried on to a limited extent at New Haven more than thirty years ago, and it is doubtless safe to say that "through the influence of the professors and pupils trained in this school, more than to any other single cause, is due the recognition of the importance of the establishment of agricultural experiment stations, first in Connecticut and subsequently throughout the whole country."

THE FIRST STATE AGRICULTURAL EXPERIMENT STATION.

In 1872 at a convention of representatives of agricultural colleges held in Washington, D. C., in response to a call issued by the United States Commissioner of Agriculture, the question of the establishment of experiment stations was discussed, and the report of a committee in favor of such institutions was adopted by the convention. On December 17, 1873, at the winter meeting of the State board of agriculture at Meriden, Conn., Professor Johnson, of the Sheffield Scientific School, and Professor Atwater, of Wesleyan University, urged the establishment of an agricultural experiment station in that State after the European pattern. A committee was appointed to consider the expediency of such a movement, and reported two days later that it was their "unanimous opinion that the State of Connecticut ought to have an experiment station as good as can be found anywhere, and that the legislature of the State ought to furnish the means for its establishment." A permanent committee was then appointed by the board to bring this matter to the attention of the public and the legislature. This committee held meetings in different parts of the State, and the following winter secured the introduction of a bill for an experiment station, which, however, was laid over until the next session of the legislature. Another year of agitation of the matter ensued. The project had many warm and enthusiastic friends, but the great mass of the farmers took little interest in the enterprise. When it had become apparent that it could not otherwise succeed, Mr. Orange Judd offered on his own part $1,000 to begin the undertaking, and on the part of the trustees of Wesleyan University, at Middletown, the free use of the chemical laboratory in the Orange Judd Hall of Natural Science.

These offers were made on condition that the legislature should appropriate $2,800 per annum for two years for the work of the station. It was thought that if by these means the work of agricultural experimentation could actually be begun the usefulness of the enterprise would be so clearly demonstrated that it would speedily receive more generous and permanent support. An act making the appropriation thus proposed was unanimously passed, and approved July 2, 1875. Early in October of the same year a chemist was on the ground, and as soon as practicable two assistants were secured. Professor Atwater was made director, and thus the first State agricultural experiment station in America was an accomplished fact. At the end of the two years provided for in the original bill the station was reorganized under the direct control of the State and permanently located in New Haven, where it has since been in successful operation, until 1882 in the chemical laboratory of the Sheffield Scientific School, and thereafter in buildings and on grounds provided by the State in the suburbs of the city.

ESTABLISHMENT OF EXPERIMENT STATIONS BY STATES AND COLLEGES.

The success which attended this first attempt to establish an experiment station in the United States was sufficient to attract the attention of advanced agriculturists throughout the country, and the example set by Connecticut was soon followed in other States. March 12, 1877, the State of North Carolina established an agricultural experiment and fertilizer control station at Chapel Hill in connection with the State University in accordance with an act of the legislature creating a department of agriculture, immigration, and statistics.

The Cornell University experiment station was organized in February, 1879, by the faculty of agriculture of the university, as a voluntary organization. From that time until the passage of the act of Congress of March 2, 1887, the work was carried on by the different professors in such time as could be spared from other studies. For a part of that time the trustees of the university appropriated money from the university funds to pay for the services of an analyst and for the purchase of supplies. All the other work was done without compensation.

The New Jersey State experiment station at New Brunswick, N. J., was established March 18, 1880, by an act of the State legislature and connected with the scientific school of Rutgers College.

The movement grew in favor with the people with each succeeding year, and in 1886 the Committee on Agriculture in reporting the Hatch bill to the House of Representatives was able to make the following statements:

Since 1881 the legislatures of several States have either recognized or reorganized the departments of agriculture in the land-grant colleges as "experiment stations," thus following substantially the course adopted by New Jersey. Such stations have been established in Maine, Massachusetts, Ohio, Tennessee, and Wisconsin. In three other States (possibly more), without legislative action, the college authorities have organized their agricultural work as experiment stations. This has been done in California, Missouri, and New York. But in addition to the twelve experiment stations specifically designated by that name a very large number of the colleges established under the act of 1862 are doing important work of a precisely similar kind. Many of them began such work immediately upon their establishment, and have since maintained it continuously; others have entered upon it more recently. The colleges in Colorado, Indiana, Kansas, Michigan, and Pennsylvania are carrying on what is strictly experiment-station work as a part of their ordinary duty.

ATTEMPT TO ESTABLISH AN EXPERIMENT STATION THROUGH PRIVATE MUNIFICENCE.

The only attempt in America to establish an agricultural experiment station through the munificence of one man, deserves recognition in this article, although it was short lived. In the year 1876, Mr. Lawson Valentine, a philanthropic and public-spirited native of Massachusetts, conducting a prosperous business in New York City, purchased a tract of several hundred acres in the township of Cornwall, Orange County, N. Y., to which he gave the name of Houghton Farm. Soon after, he conceived the idea of establishing at this place a series of systematic agricultural experiments. Mr. Valentine naturally took for his model the work of Lawes and Gilbert at Rothamsted, England, but with modifications suited to American conditions.

In the summer of 1879 Dr. Manly Miles, of Michigan, was engaged as director of experiments, and during the next eighteen months he laid out suitable fields, constructed a system of drainage, and visited the principal stations of Europe for the purpose of studying plans and methods of investigation. Early in 1881 the scheme was reorganized, and Maj. Henry E. Alvord, of Massachusetts, was placed in charge as general manager, with these instructions from the proprietor:

First, conduct the farming operations in accordance with the best known methods and under the best possible organization and management, with a view of educating and enlightening others by furnishing valuable examples and results in practical agriculture. Second, organize and operate a scientific department, devoted to agricultural investigation and experiment, to be of the highest order, and such as to command the respect, interest, and cooperation of leading scientists of this and other countries.

Upon this basis Houghton Farm was conducted for about five years. The experiment department, with its own organization, assignment of real estate, and equipment, was maintained at an expense to the proprietor approaching $20,000 per annum. The experimental work inaugurated was grouped under four heads: (1) Agricultural physics; (2) plant growth; (3) diseases of plants; and, (4) animal growth and production. The scheme included four corresponding series of publications, issued at irregular intervals. Papers were published and distributed during 1882, 1883, and 1884 in the three series first named. The main work consisted of field experiments in growing maize. Thirty-six plats of an area of one-fifth acre each were continuously cultivated for several years, and the records were partly published. Extensive provisions were made for work in breeding and feeding dairy cattle and mutton sheep and in dairy products, but no pamphlet publications were issued on this line. The death of Mr. Valentine in 1888 put an end to this enterprise.

ESTABLISHMENT OF EXPERIMENT STATIONS BY CONGRESS.

The convention of delegates of agricultural colleges which met at Washington, D. C., in 1883 discussed and indorsed the project for the establishment of stations in connection with the colleges by appropriations from the National Treasury, in accordance with the terms of a bill already introduced into the House of Representatives by C. C. Carpenter, of Iowa. Congress, however, was not yet quite ready to undertake so large a scientific enterprise in this direction, and the bill was not put upon its passage. Meanwhile the number of stations was steadily increasing, and the interest of practical farmers as well as men of science was more and more excited by the reports of the results of the experiments which the stations had completed. On July 8, 1885, a convention of agricultural colleges and experiment stations met at the Department of Agriculture at Washington City, in response to a call issued by Hon. Norman J. Colman, the Commissioner of Agriculture. Almost the first thing which this convention did was to pass a resolution "that the condition and progress of American agriculture require national aid for investigation and experimentation in the several States and Territories; and that therefore this convention approves the principle and general provisions of what is known as the Cullen bill of the last Congress, and urges upon the next Congress the passage of this or a similar act." (The Cullen bill was in its general provisions similar to the bill afterwards passed by Congress and now popularly known as the Hatch Act.) So earnest was the convention in this matter that it appointed a committee on legislation, which was very efficient in securing the passage of the amended bill.

In a later session the convention passed resolutions urging the creation of a branch of the Department of Agriculture at Washington City, which should be a special medium of intercommunication and exchange between the colleges and stations, and which should publish a periodical bulletin of agricultural progress, containing in a popular form the latest results in the progress of agricultural education, investigation, and experimentation in this and in all other countries. Provision was also made for a permanent organization by the appointment of a committee to cooperate with the United States Commissioner of Agriculture in determining the time of meeting and the business of the next convention, and in forming a plan for a permanent organization.

At the next session of Congress the experiment-station enterprise was again called to the attention of the House of Representatives by the bill which was introduced by William H. Hatch, of Missouri, and referred to the Committee on Agriculture. This committee made a favorable report March 3, 1886, and nearly a year later the bill was passed by Congress, and was approved by the President March 2, 1887.

The Hatch Act provides that $15,000 a year shall be given out of the funds proceeding from the sale of public lands to each State and Territory for the establishment of an agricultural experiment station, which must be a department of the land-grant college, except in the case of those States which had established experiment stations as separate institutions prior to the passage of the act.

The duties of the stations are thus defined:

SEC. 2. That it shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies for the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under a varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manures, natural or artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States or Territories.

In order that the funds from the National Treasury might be for the most part devoted to agricultural investigations, only $3,000 of the first year's appropriation for each station was to be expended for buildings, and thereafter only $750 a year could be so expended.

That the farmers of the country may receive prompt information regarding the work of the stations, it is provided that in addition to "full and detailed" annual reports of their operations and expenditures "bulletins or reports of progress shall be published at said stations at least once in three months, one copy of which shall be sent to each newspaper in the States or Territories in which they are respectively located, and to such individuals actually engaged in farming as may request the same and as far as the means of the station will permit." The franking privilege is also given for the station publications. Financial and other reports of the stations are to be sent to the Secretary of Agriculture and the Secretary of the Treasury, but no provision is made for auditing the accounts by officers of the United States or for any supervision of their work by the federal authorities. It is, however, made the duty of the Secretary of Agriculture "to furnish forms, as far as practicable, for the tabulation of results of investigation or experiments; to indicate from time to time such lines of inquiry as to him shall seem most important; and, in general, to furnish such advice and assistance as will best promote the purpose of this act."

Owing to the failure of Congress to make a specific appropriation to meet expenditures under the Hatch Act during the fiscal year in which it was passed, the Treasury Department ruled that no money could be paid to the stations during that year. It was therefore necessary to wait until the following session of Congress before active operations could be begun under the act. Meanwhile the State legislatures, one after another, gave their assent to the provisions of the act and designated the institutions which were to receive its benefits. Boards of management were organized, working staffs were appointed, buildings were located and planned, land was selected for field experiments, and in general the equipment of the stations was provided for. When the appropriation was made by Congress in 1888, it was included in the general appropriation act of the Department of Agriculture, though the head of that Department was at that time in no way responsible for the expenditure of this fund, and this precedent has uniformly been followed in succeeding years.

In 1894 Congress adopted the recommendation of the Secretary of Agriculture and gave this Department authority to examine the expenditures of the stations under the Hatch Act and report on their legality. This led to much closer relations between the Department and the stations than had hitherto existed. As soon as practicable after the passage of this act the required schedules were prepared on the basis of those already in use at the stations and distributed. In order that the Department might have accurate and complete information regarding the work and expenditures of the stations as the basis for the required reports to Congress, it was decided that the stations should be regularly visited by representatives of the Office of Experiment Stations, and this has been done each year since. In connection with these visits inquiries are made regarding the management and work of the stations and their relations to the land-grant colleges. Their methods of keeping accounts are also examined. Conferences are held with the station officers and members of the governing boards, in which not only financial policy, but also lines and methods of work are discussed. On the basis of this visitation of the stations, together with their financial statements and published reports and bulletins, a report on the work and expenditures of the stations is annually made to Congress.

In connection with the examination of the expenditures of the stations it became necessary for the Department of Agriculture to define its views regarding the limitations of the Hatch Act, and this was accordingly done in a series of rulings issued March 10, 1896. The most important of these were to the effect: (1) That permanent substations were contrary to the spirit and intent of that act; (2) that land could not be purchased or rented with the Hatch fund; (3) that farm operations were permissible only so far as they definitely constituted a part of agricultural investigations or experiments; (4) that funds arising from the sale of farm products or other property in the possession of a station, as the result of expenditures of the Hatch fund, rightfully belonged to the station, and therefore should be expended for station purposes.

GROWTH OF THE EXPERIMENT STATIONS.

In 1893 the stations for the first time united in making a collective exhibit of the methods and results of their work. This exhibit was made in connection with the World's Columbian Exposition at Chicago. The Office of Experiment Stations and the Association of American Agricultural Colleges and Experiment Stations acted in cooperation in the general management of the exhibit. The then Director of the Office of Experiment Stations, Prof. A. W. Harris, represented the Office, and the association was represented by a committee, of which Dr. H. P. Armsby, director of the Pennsylvania State College Experiment Station, was chairman. The station work was exhibited in nine sections—botany, soils, fertilizers, crops, horticulture, entomology, feeding stuffs, animal nutrition, and dairying. There were also botanical, biological, and chemical laboratories, in which some of the simpler station operations were carried on by way of illustration. The publications of the stations and of the Office of Experiment Stations were shown, together with a large number of photographs and charts illustrating the buildings, equipment, and work of the stations. The exhibit was in general of a popular character, and was installed in the Agricultural Building. In connection with this exhibit a popular digest of the publications of the stations was made by this Office and published as Bulletin No. 15, entitled "Handbook of experiment-station work." At the same exposition a very extensive test of the different breeds of dairy cows was made under direction of a committee of station officers. In this test a daily record was kept of the food, milk, fat in the milk, and butter or cheese yield of each cow. A copy of this record, which comprises about 1,000 large sheets of tabulated matter, has been filed at the Department of Agriculture, where it is accessible to students and investigators.

The growth of the stations as regards their number, resources, personnel, and publications is shown by the following general statistics for the earlier years of their operations under the Hatch Act as compared with those for the year 1899. In 1888 the 46 stations in 38 States and one Territory received the national funds, making a total appropriation of $585,000, to which must be added about $125,000 derived from State appropriations, fees for fertilizer analyses, sales of farm products, etc., and $10,000 appropriated by Congress for the Office of Experiment Stations. The whole amount used for experiment-station purposes in the United States in 1888 was therefore about $720,000. In 1889 these stations published 45 annual reports and 237 bulletins.

In 1890, when more complete statistics of the stations were published by the Office of Experiment Stations for the first time, it was stated that the "stations employ 429 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors, 66; chemists, 101; agriculturists, 63; horticulturists, 47; botanists, 42; entomologists, 33; veterinarians, 19; meteorologists, 11; biologists, 4; viticulturists, 2; physicists, 3; geologist, 1; mycologists, 2; microscopists, 4; irrigation engineer, 1; in charge of substations, 16; secretaries and treasurers, 21; librarians, 5; clerks, 18. There are also 42 persons classified under the head of miscellaneous, including superintendents of gardens, grounds, and buildings; foremen of farms and gardens; apiarists; herdsmen, etc. During 1890 the stations have published 36 annual reports and 225 bulletins. The mailing list of the stations now aggregates about 340,000 names."

In 1899 agricultural experiment stations were in operation in all the States and Territories and in Alaska and Hawaii. In each of the States of Alabama, Connecticut, New Jersey, and New York a separate station was maintained wholly or in part by State funds, and in Louisiana there were three stations receiving joint support from national and State funds. Excluding the branch stations established in several States, the total number of stations in the United States in 1899 was 56. Of these, 52 received the appropriation provided for in the act of Congress above mentioned. The total income of the stations during 1899 was $1,143,334.93, of which $720,000 was received from the National Government, the remainder, $423,334.93, coming from the following sources: State governments, $240,300.20; individuals and communities, $12,100; fees for analyses of fertilizers, etc., $75,294.42; sales of farm products, $69,312.60; miscellaneous, $26,327.71. In addition to this the Office of Experiment Stations had an appropriation of $40,000, including $10,000 for the Alaskan investigation. The value of additions to equipment of the stations in 1899 is estimated as follows: Buildings, $27,218.64; libraries, $10,796.15; apparatus, $16,917.07; farm implements, $10,784.88; live stock, $16,265.95; miscellaneous, $22,521.93. Total, $104,504.62. The stations employed 678 persons in the work of administration and inquiry The number of officers engaged in the different lines of work was as follows: Directors, 71; chemists, 148; agriculturists, 68; experts in animal husbandry, 9; horticulturists, 77; farm foremen, 21; dairymen, 23; botanists, 52; entomologists, 48; veterinarians, 26; meteorologists, 17; biologists, 7; physicists, 7; geologists, 5; mycologists and bacteriologists, 20; irrigation engineers, 5; in charge of substations, 16; secretaries and treasurers, 24; librarians, 9; and clerks, 43. There were also 48 persons classified under the head of "miscellaneous," including superintendents of gardens, grounds, and buildings; apiarists; herdsmen, etc. Three hundred and eight station officers do more or less teaching in the colleges with which the stations are connected.

During 1899 the stations published 445 annual reports and bulletins. Besides regular reports and bulletins, a number of the stations issued press bulletins, which were widely reproduced in the agricultural and county papers. The mailing list of the stations now aggregates 523,970 names. Correspondence with farmers and calls upon station officers for public addresses at institutes and other meetings of farmers are more numerous than ever. The station officers continue to contribute many articles on special topics to agricultural and scientific journals.

The number of stations has increased from 46 in 1888 to 56 in 1899. The annual income of the stations, including the appropriation for the Office of Experiment Stations, has risen from about $720,000 in 1888 to $1,183,000 in 1899. Of this amount, about $125,000 was derived from State appropriations, fees for fertilizer analyses, sales of farm products, etc., in 1888, and $423,000 in 1899. In 1889, 393 officers were employed at the stations, while in 1899 their number had increased to 678. The stations published 282 annual reports and bulletins in 1889, and 445 in 1899.

The stations are at present conducting a wide range of scientific research in the laboratory and plant house and an equally large amount of practical experimenting in the field, the orchard, stable, and dairy. Practically all the stations are keeping a record of meteorological data, while 10 are making special studies of problems relating to meteorological phenomena and climatic conditions.

Thirty-six stations are at work investigating soils, their geology, physics, and chemistry, or conducting soil tests with fertilizers or in other ways. Twenty-one stations are studying questions relating to drainage and seepage or to irrigation in the field or greenhouse, and with orchard, garden, or farm crops. Thirty-three stations are making analyses of commercial and homemade fertilizers or are conducting field experiments with fertilizers. At least fifteen stations either exercise a fertilizer control in their respective States or make analyses on which the control is based. All the stations are studying the more important crops, either with regard to their composition, nutritive value, methods of manuring and cultivation, and the best varieties adapted to individual localities, or with reference to systems of rotation.

Forty-seven stations are investigating the composition of feeding stuffs, making digestion experiments, conducting feeding experiments for milk, beef, mutton, or pork, or studying different methods of feeding. Twenty-nine stations are investigating subjects relating to dairying, including the chemistry and bacteriology of milk, creaming, butter making, or the construction and management of creameries. Studies on the food and nutrition of man, including the composition and digestibility of foods and metabolism, are being conducted at 14 stations. Fifty-two stations are doing chemical work and often are studying methods of analysis. Botanical studies occupy more or less of the attention of 47 stations, including investigations in systematic and physiological botany, with special reference to the diseases of plants, testing of seeds with reference to their vitality and purity, classification of weeds, and methods for their eradication. Fifty-three stations work to a greater or less extent in horticulture, testing varieties of vegetables, and large and small fruits, and making studies in varietal improvement and synonomy. Several stations have undertaken operations in forestry. Thirty-six stations investigate injurious insects with reference to their restriction or destruction. Twenty-four stations study animal diseases and the methods for their prevention or cure. At least 5 stations are engaged in bee culture and 8 in experiments with poultry. One or more stations have made investigations on miscellaneous subjects, such as the following: Technology of wine, olive oil, and vinegar, preservation of fruits and vegetables, the draft of farm implements, road making, the manufacture of beet, cane, sorghum, and maple sugar, oyster culture, etc.

At first there was a disposition, especially in the region west of the Mississippi River, where the area of the States and Territories is large and the population scattered, to divide the Hatch fund and maintain substations in different localities. This greatly weakened the effectiveness of the station work and in some cases prevented the establishment of the stations on a firm basis. During the past few years, largely through the efforts of the Office of Experiment Stations, these substations have been generally abolished. In California, Minnesota, Texas, Michigan, Ohio, and New Mexico one or more substations are maintained with the aid of State funds, which are used to supplement the national fund, and thus make the extension of the station work feasible and successful.

RELATION OF THE FEDERAL GOVERNMENT TO THE STATIONS.

The agricultural experiment stations in the United States are State institutions, supported in part by funds given by the National Government to the States to be used for their maintenance. They have also received the franking privilege under federal authority. The direct management of the stations is wholly in the hands of State officers. The stations, however, sustain certain definite relations to different branches of the Federal Government. The appropriations called for by the Hatch Act are made by Congress from year to year. They come under the head of annual, rather than permanent, appropriations, Congress having the right to refuse to make them at any time. The Congressional appropriations for the stations have thus far been included in the appropriation acts for the Department of Agriculture. After a State or Territory has given its assent to the provisions of the Hatch Act and designated the college which is to receive its benefits, the money is paid directly from the United States Treasury to the treasurer or other officer of the institution with which the station is connected, who has been certified to the Treasury as the proper person to receive this fund. The payments are made quarterly in advance, as provided by law.

Regulations governing the use of the franking privilege by the stations are made by the Post-Office Department.

As departments of the colleges receiving the benefits of the land-grant act of 1862, reports of the stations are annually sent to the Secretary of the Interior, who is represented in his relations with these institutions by the Bureau of Education.

The stations have much more intimate relations with the Department of Agriculture than with any other branch of the Federal Government. In its general relations with the stations, as well as in the supervision of their expenditures under the Hatch Act, the Department is represented by the Office of Experiment Stations, an account of which is given below.

From time to time Congress has given the Department of Agriculture funds for special investigations, with the provision that the Department shall, as far as practicable, cooperate with the experiment stations in carrying on these investigations. Notable instances of such appropriations are those for nutrition and irrigation investigations, which have been in charge of the Office of Experiment Stations, the inquiries conducted by the Office of Public Road Inquiries, and investigations with forage plants, in charge of the Division of

Agrostology. There has been an increasing amount of cooperation beween the Department and the stations in other ways, including all the general lines of work in which the scientific Divisions of the Department are engaged. The Department has also afforded to station officers the privileges of its laboratories, collections, and Library to an increasing extent from year to year.

THE OFFICE OF EXPERIMENT STATIONS.

The Office of Experiment Stations was established as a branch of the Department to represent the Secretary of Agriculture in his relations with the experiment stations as provided for by the Hatch Act. After the passage of the Morrill Act of 1890 for the further endowment of the agricultural colleges, this Office was made the depository of the financial and statistical reports of these institutions, which are annually sent to the Secretary of Agriculture. The Office was thus furnished with considerable material upon which to base publications regarding the development of education in agriculture in this country. This work has since been broadened to include a survey of the institutions for agricultural education in foreign countries. More recently the Office has been charged with the supervision of experimental investigations in agriculture in Alaska and of special investigations on human nutrition and on irrigation, which are carried on largely in cooperation with the agricultural colleges and experiment stations.

RELATIONS OF THE OFFICE WITH EXPERIMENT STATIONS.

In its general advisory relations with the experiment stations in the different States and Territories, the Office of Experiment Stations endeavors to help the stations in a variety of ways. This work is performed partly by personal conferences with station officers and partly by correspondence. It includes such things as advice regarding the organization and management of the stations, the choice of officers, the lines of work to be undertaken, the planning, recording, and execution of special lines of work, the nature and form of publications, the plans for station buildings, the materials, apparatus, and literature required for use in connection with different kinds of agricultural investigation. By its work in this direction, the Office has been enabled to offset, to a certain extent, the difficulties in station management and work, especially those arising from frequent changes in the governing boards and staffs of the stations, and has secured an increasing amount of uniformity in the general policy of station management throughout the country. It has, at the same time, been clearly recognized that each station is an independent State institution, for the conduct of which the United States does not assume responsibility further than is involved in the requirements of the national law under which the stations are organized and the terms on which appropriations toward their maintenance are made by Congress year by year.

The Office has endeavored to maintain a broad and consistent policy regarding the general principles on which experiment-station management and work should be based, and to aid the individual stations in their attempts to adjust these principles to the varying needs and conditions of the different States and Territories. It has also sought to promote their cooperation with each other, with the different branches of the Department of Agriculture, and with the farmers; and as a central agency established for their benefit, it has helped to bring them into relations with similar institutions abroad and to promote their interests in matters involving transactions with different branches of the United States Government.

As previously stated, the Office also has supervision of the expenditures of the stations under the Hatch Act, and annually prepares a report of the work and expenditures of the stations, which is made to the Secretary of Agriculture for transmission to Congress. This report briefly describes the work, income, and expenditures of each station, with such criticisms as are deemed desirable, and also includes a general statement regarding the condition and progress of the station enterprise as a whole during the year.

The Office collects and catalogues all the publications of the stations. This is done partly that it may have the material for its own publications and partly to make a permanent library of the station publications.

PUBLICATIONS OF THE OFFICE.

The Office of Experiment Stations prepares a large number of publications which are largely based on those of the experiment stations in this country and abroad, or are reports of the special investigations in charge of the Office. One of the most important of these publications is the Experiment Station Record, which is issued in volumes of twelve numbers each, and is now in its eleventh volume. It comprises abstracts of the bulletins and annual reports of the stations, the publications of the Department of Agriculture, books, journals, and miscellaneous publications containing reports of investigations in agricultural science in different countries of the world; special articles by American and foreign experts in agricultural science; editorials on important matters regarding the progress of agricultural education and science, with suggestions of lines of inquiry for the stations, and notes on the organization, equipment, and development of institutions for agricultural education and research at home and abroad.

Detailed author and subject indexes accompany each volume. This journal is sent without charge to institutions for agricultural education and research in this country and the officers of such institutions, to similar institutions in foreign countries, important libraries, and to a select list of scientists and specialists who cooperate with the Department by furnishing information, by exchanging publications, or otherwise. It is also sold by the Superintendent of Documents at 10 cents a number, or $1 per volume.

The technical bulletins of the Office include special reports to Congress as required by law, reports of the investigations in charge of this Office on the nutrition of man and on irrigation, monographs on special subjects based on the work of the experiment stations, bulletins containing statistics and general information regarding institutions for agricultural education and research, and the proceedings of the Association of American Agricultural Colleges and Experiment Stations.

In 1889 a series of Farmers' Bulletins was begun in this Office with a view to making a popular record of the results of work at the experiment stations for general distribution among the farmers of the country. After the scope of this series was enlarged and it was made a general series for the Department, the Office continued to prepare, or to obtain from officers of the experiment stations, articles of a popular character on different subjects which might properly be included in this series. Latterly the Office has restricted these articles to subjects connected with the special investigations in its charge and résumés of the publications of the experiment stations. The latter are grouped together in a subseries entitled "Experiment station work." This title has been given to Farmers' Bulletins prepared in this Office, in which a number of short articles on different subjects based on the publications of the experiment stations are grouped together to form single bulletins. As stated in a note inserted in each number of this series, "The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint our farmers in a general way with the progress of agricultural investigation on its practical side."

Each article included in the "Experiment station work" is signed by the person who prepares it. The meaning of technical terms necessarily used in these articles is explained in an appendix. Illustrations are used as far as seems desirable. Whenever the number of these bulletins is sufficiently large to make a volume of convenient size an index will be prepared covering the numbers to be included in the volume. In this way, as time goes on, it is expected that there will be in libraries and in the homes of many farmers a series of volumes containing a popular record of the practical results of the work of the stations. Through this series the farmer in any part of the country is enabled to ascertain the most important practical things the stations are accomplishing wherever they may be located.

The Office also publishes a "Card index of experiment-station literature." This is a subject index arranged on a decimal system. Each card contains the title of the article, the name of the author, a bibliographical reference to the experiment-station publication containing the article, and also to the Experiment Station Record, and a brief abstract showing the nature and scope of the article. The number of cards thus far prepared is 19,000, covering the publications of the stations from 1888 to 1897. A set of the index is furnished to each agricultural college and experiment station in this country and to the boards or commissioners of agriculture in the several States. The index is also sold to subscribers at the rate of $2 per thousand cards, and $1.25 for a set of division cards. Three hundred sets are printed.

The Office also prepares a variety of brief documents in the form of circulars, schedules, articles for the Yearbook of the Department, etc.

From its organization in 1888 up to January 1, 1900, this Office issued 311 documents, which may be classified as follows: Experiment Station Record, 11½ volumes, 119 numbers; technical bulletins, 72; Farmers' Bulletins, 46; circulars, 43; schedules, separates, etc., 31. In 1899 the total number of copies of publications of this Office printed was 1,200,000, of which 1,000,000 were Farmers' Bulletins.

ALASKA EXPERIMENT STATIONS.

Beginning with 1897, agricultural investigations have been carried on in Alaska under the direction of the Office of Experiment Stations. These investigations have thus far consisted very largely of an agricultural survey, with a view to determining the agricultural capabilities of this region. Definite experiments in growing cereals, flax, and vegetables have been conducted at several points along the coast. During the past year this work has been organized on a more permanent basis with a view to the establishment of regular experiment stations in Alaska. The erection of a headquarters building to contain offices and laboratories has been begun at Sitka, and land has been cleared for experimental purposes at Sitka and Kenai in Cook Inlet. Oats, barley, and wheat have been successfully grown to maturity at both these places, and rye and flax have also been matured at Sitka. Definite information has been collated showing that a considerable variety of vegetables, such as potatoes, cabbages, cauliflower, turnips, lettuce, and spinach may be successfully grown in different parts of Alaska, including interior localities. Grasses and forage plants grow luxuriantly over large areas in Alaska, and live stock has already been kept there to a sufficient extent to warrant the belief that a large animal industry may be developed. Three reports on the investigations in Alaska have been published. The work in Alaska is in immediate charge of Prof. C. C. Georgeson.

NUTRITION INVESTIGATIONS.[1]

In 1894 Congress made a special appropriation of $10,000 "to enable the Secretary of Agriculture to investigate and report upon the nutritive value of the various articles and commodities used for human food." General supervision of this inquiry was assigned to the Office of Experiment Stations, and Prof. W. O. Atwater was appointed special agent in charge of nutrition investigations, with headquarters at Middletown, Conn. At the same time Congress authorized the experiment stations to conduct investigations on the food of man, and they were directed to report progress in their work in this line to the Secretary of Agriculture. The investigations, in charge of this Office, have been carried on in connection with colleges, experiment stations, and philanthropic organizations in different parts of the country. Technical bulletins containing accounts of investigations on food and nutrition of man have been published, as well as Farmers' Bulletins based on such investigations.

IRRIGATION INVESTIGATIONS.[1]

In the appropriation act for the Department of Agriculture for the fiscal year ending June 30, 1899, $10,000 was appropriated by Congress for irrigation investigations by the Department of Agriculture, and this was increased to $35,000 for the current fiscal year. By order of the Secretary of Agriculture supervision of this work was assigned to the Director of the Office of Experiment Stations. It was decided to undertake work in two general lines: (1) The collation and publication of information regarding the laws and institutions of the irrigated region in their relation to agriculture, and (2) the publication of information regarding the use of irrigation waters in agriculture as determined by actual experience of farmers and experimental investigations. A headquarters for these investigations has been established at Cheyenne, Wyo. They are carried on under the immediate direction of Prof. Elwood Mead, and as far as practicable are made in cooperation with the experiment stations in different States. Work in this line has now been undertaken in fifteen States and Territories.

RELATIONS OF THE STATIONS WITH ASSOCIATIONS.

The experiment stations, as well as the colleges with which they are connected, are brought together so as to form a national system of agricultural education and research through the Association of American Agricultural Colleges and Experiment Stations. The work of this association is carried on by means of conventions composed of one delegate appointed by each of the land-grant colleges and agricultural experiment stations in the United States, together with

[1] More detailed account of these investigations are given in a separate article in this Yearbook.—Ed.

delegates representing the Department of Agriculture, the Office of Experiment Stations, and the Bureau of Education of the Department of the Interior. Annual meetings are held in different parts of the country, at which questions relating to the management and work of the stations, as well as of the colleges, are discussed in the general assembly and in a number of sections.

The proceedings of the association are edited by the chairman of its executive committee and the Director of the Office of Experiment Stations and are published by the Department of Agriculture as bulletins of this Office. In the interval between meetings of the association much useful work for the promotion of the general interests of the agricultural colleges and experiment stations is performed by the executive committee and standing and special committees of the association. The association has done much to establish and strengthen the stations and to aid in their administration on a permanent and substantial basis.

The stations are also largely represented in the associations of Official Agricultural Chemists, Economic Entomologists, and Experiment Station Veterinarians, through which the uniformity and efficiency of the station work in chemistry, entomology, and veterinary science, with special reference to the methods employed, are greatly promoted.

ORGANIZATION OF THE STATIONS.

The stations organized under the Hatch Act are by law departments of the colleges receiving the benefit of the land-grant act of July 2, 1862, and of supplementary acts relating to similar colleges established in the States which have been admitted to the Union since the passage of that act, as well as to those in the Territories. The Hatch Act, however, made an exception in favor of State agricultural experiment stations which had been established separate from the land-grant colleges prior to the passage of the act. In this way State stations are maintained in Connecticut, New York, and Ohio, which are not connected with colleges and yet receive, in whole or in part, the benefits of the Hatch Act. In New Jersey there is a station which is supported by State funds as distinct from the station which receives the Hatch funds, but both stations are located at the land-grant college and have the same director.

The stations, which are departments of the colleges, are, as a rule, under the general management of the governing boards of these institutions. The separate State stations have their own governing boards. The governing boards of the stations are quite commonly appointed by the governor of the State, but in a few cases are elected by the people. In a few instances the State board of agriculture is the governing board of the college and station. The more immediate supervision of station affairs is often intrusted to a standing committee of the governing board.

As a rule, the duties of the governing board are confined to determining in a general way the policy and lines of work, appointing the members of the staff and fixing their terms of office and compensation, deciding on the character and extent of expenditures, and approving and auditing the accounts. In some cases, however, the governing boards determine and supervise the work and expenditures of the station in considerable detail. This was more generally true in former years than at present. As the stations have developed, it has been found desirable to intrust the planning and execution of their work more fully to the director and other expert officers.

The president of the college with which the station is connected, as a rule, holds the same relation to the station that he does to other departments of the college, that is, he is the chief executive officer of the institution, including the experiment station, and represents the institution before the governing board, of which he is often an ex-officio member. In a few instances the president has been relieved of all responsibility for the station, its director reporting directly to the governing board. In fourteen States and Territories the president of the college is at present also director of the station.

Elsewhere the director is a separate officer, who, in addition to general executive duties connected with the station, carries on investigations in some special lines, or combines teaching in the college with his work for the station. Thus, the station director may at the same time be the chemist or agriculturist of the station and the professor of chemistry or agriculture in the college. In some stations the director has large powers and responsibilities in the management of the station. In other States the planning of the work and even details of administration are largely committed to a council composed of the heads of the different divisions of the station, or these officers and some members of the governing board.

Besides the president of the college and the director, the station staff usually comprises several scientific experts in charge of special lines of work (as dairying, horticulture, chemistry, entomology, or diseases of plants and animals) and scientific assistants. The members of the staff may be employed exclusively for experiment-station work, but in a large number of instances they combine this with instruction in the college. In addition to the scientific force there are usually persons of practical experience employed as foremen of farms, dairymen, feeders of cattle, etc., and clerical assistants, including accountants, stenographers, and typewriters. Women are often employed in these clerical positions. Laborers are employed regularly by the year or month, or work as occasion may demand by the day or hour.

A considerable number of students of the colleges are employed as assistants and laborers at the stations. Special experts, scientific assistants, and other workers are from time to time employed by the stations for the conduct of particular investigations.

FIG. 1.—ADMINISTRATION AND LABORATORY BUILDING OF OHIO STATION.

FIG. 2.—DAIRY AND BIOLOGICAL BUILDING OF NEW YORK STATE STATION.

FIG. 1.—CHEMICAL AND BIOLOGICAL LABORATORY OF KENTUCKY STATION.

FIG. 2.—DAIRY BUILDING OF WISCONSIN STATION.

FIG. 1.—BARN OF MINNESOTA STATION.

FIG. 2.—EXPERIMENT PLATS OF PENNSYLVANIA STATION.

In cooperative experiments with farmers, the station usually furnishes the plans of work and the seeds, fertilizers, fungicides, or other materials required by the experiment, and makes the chemical or other examinations of the soils, fertilizers, or crops necessary to determine the data or results sought in the experiment. The farmer on his part furnishes the land, orchards, labor, etc., most commonly without charge to the station.

EQUIPMENT OF THE STATIONS.

The stations very generally make use of buildings and land supplied by the colleges or by the States. Many of these buildings and farms are used jointly by the college and station. The buildings include administration buildings (Pl. XLIII, fig. 1), libraries, chemical, botanical, bacteriological, and other laboratories (Pl. XLIII, fig. 2, and Pl. XLIV, fig. 1): vegetation houses, insectaries, dairy buildings (Pl. XLIV, fig. 2), barns (Pl. XLV, fig. 1), silos, piggeries, and poultry houses, together with special buildings for particular experiments, such as those in sugar making, tobacco curing, and the treatment of animal diseases. The stations are generally well equipped with scientific apparatus, farm implements, and live stock. A portion of the station land is commonly laid out in permanent plats for experimental purposes (Pl. XLV, fig. 2).

LINES OF WORK OF THE STATIONS.

Speaking broadly, the work of the experiment stations in the United States corresponds in scope and extent with the complexity of their organization. It is therefore difficult to make general statements regarding their work which will apply to the actual operations of any one of the stations. A strict interpretation of the Hatch Act would require that the funds received from the National Government under this act should be devoted solely to original investigations and demonstration experiments and the publication of their results. In many States, however, the stations have funds, derived from the State government or other sources, which may be used for inspection work in various lines, the compiling of information useful to farmers, and miscellaneous purposes connected with the promotion of agriculture.

In a general way the work of the stations in the United States may be grouped under the following heads: (1) Scientific and practical investigations involving original features; (2) experiments for the verification or demonstration of the results of original investigations made at the stations or elsewhere; (3) studies of natural agricultural resources and conditions; (4) inspection and other control duties performed on behalf of agriculture; (5) the dissemination of original and compiled information.

It will, however, readily be understood that most of the enterprises of the stations are of a mixed character. Originality will, as a rule, be found only in some particular features of an investigation or in the adaptation of well-known facts or principles to special conditions. In the following outline the investigations of the stations which on the whole have most generally contained original features are grouped together, though in many cases they might with equal propriety be classified as demonstration experiments.

INVESTIGATIONS INVOLVING ORIGINAL FEATURES.

The investigations of the stations may be classified in a general way on the basis of the different divisions found in their organization. Thus, it may be said that the investigations of the stations comprise studies in physics, chemistry, botany, zoology and especially entomology, geology, meteorology, agronomy (plant production), horticulture, forestry, physiology (of man and domestic animals), zootechny (animal industry), veterinary science, agrotechny (agricultural technology), including especially dairying, and rural engineering.

In most of these lines the investigations have included studies with reference to the improvement of methods of research, devising of new apparatus and appliances, the relation of scientific principles to the science and practice of agriculture, the working out of new practical applications on the basis of well-known facts and principles, or the solution of special problems. The statements following may serve to indicate in what directions the investigations have chiefly been pursued.

Under the head of physics, considerable attention has been given in recent years to studies on soils, especially as regards the methods for the physical examination of soils, the movement of soil water, and the apparatus required for such investigations.

In chemistry, studies with a view to the improvement of methods of analysis have occupied the attention of a considerable number of stations. This work has been done quite largely in connection with the Association of Official Agricultural Chemists. It has related chiefly to methods of analysis of soils, fertilizers, plants, foods, and feeding stuffs. They have also cooperated with this association in determining food standards as a basis for the determination of adulteration. A number of pieces of special chemical apparatus have been devised at the stations. These have included apparatus adapted to particular kinds of investigations or intended to increase the speed or multiply the operations of laboratory processes for scientific or practical purposes and devices for making the chemical examinations required in agricultural industries. A very large number of analyses of economic plants, foods and feeding stuffs, dairy products, fertilizers, and other agricultural materials, especially those distinctively American, have been made for the first time in the chemical laboratories of the stations. A considerable number of purely chemical investigations have been conducted. Chemistry has usually been an adjunct to the investigations in the fertilizer requirements of plants, human and animal nutrition, and dairying.

In botany, considerable systematic work has been done, especially in the newer States. New species of useful and injurious plants have been discovered and described. Herbaria, showing with more or less completeness the economic flora of individual States, have been collected. New light has been thrown on the botanical relations of species of economic plants. The botanical work of the stations has, however, been most largely along the lines of vegetable physiology and pathology and bacteriology. The studies in vegetable physiology have included investigations of special problems and the devising of methods and apparatus for such studies. In vegetable pathology much has been done in working out the life histories of fungi injurious to cultivated plants and in devising methods and apparatus for the repression of diseases of plants. The bacteriological work of the stations has included the isolation, culture, and description of many species of useful and pathogenic bacteria in air, soil, fertilizers, plants, foods, feeding stuffs, and other agricultural products, and those affecting useful and injurious animals. Methods and apparatus for bacteriological investigations have been devised and means for the repression of pathogenic bacteria have been worked out. The distribution and repression of weeds have been studied by numerous station botanists.

In zoology, by far the most important work of the stations has been along the lines of economic entomology. This has included the collection of large numbers of specimens of insects with a view to the determination of their economic importance in different regions; the description of many new species and the working out of their life histories in whole or in part; additions to our knowledge of many beneficial and injurious insects, including in many cases the completion of their life histories; studies in the breeding of insects, especially as a means for their investigation; the discovery or invention of methods and appliances for the repression of injurious insects; and the devising of methods and appliances for the study of insects.

In other lines of zoological investigation systematic and other studies have been made of injurious mammals (especially gophers and rabbits) and useful and injurious birds. There have also been special investigations relating to the life history and culture of oysters and the life history of nematodes.

Under the head of agronomy (plant production) a large amount of work has been done in the introduction of new varieties of crops adapted to special regions or particular economic purposes. Investigations in the improvement of varieties by selection and by plant breeding have been undertaken. Fertilizer and tillage experiments have been conducted, drainage and irrigation problems investigated, and methods of harvesting and storage studied. Some work has also been done in studying methods of investigation.

In horticulture, the stations have given most attention to testing the adaptability of varieties to different regions. In addition to this there have been studies of the selection and breeding of horticultural plants and the methods of culture, grafting, and pruning. Considerable attention has been given to questions relating to the growing of horticultural plants under glass. Valuable introductions of new and hardy fruits have been made. Native fruits have been studied and improved and wild species brought under cultivation.

Combinations of forcing-house and field methods of culture of a number of American garden crops have been introduced. Irrigation as a feature of truck gardening and fruit growing in regions of considerable rainfall has formed a feature of horticultural work at several of the experiment stations, and the value of subirrigation in greenhouses with certain forcing crops thoroughly demonstrated. Fertilizer experiments with numerous horticultural crops have thrown much new light on the subject of intensive manuring. The utilization of fruits (more especially the unmerchantable fruits) in the making of jelly, preserves, fruit sirups, and cider has been investigated. Some of the stations have given considerable attention to the beautifying of home and school grounds by the introduction of ornamental trees, shrubs, flowers, etc., not previously grown in their localities.

In forestry, the work of the stations has been principally confined to the testing of different varieties of trees with reference to their adaptability to particular regions and problems connected with the reforesting of treeless regions.

In the physiology of man and the domestic animals, the work of the stations has been largely along the line of nutrition. The most important piece of work in this line has been the devising of a special form of respiration calorimeter at the Storrs experiment station, in Connecticut, as described elsewhere. The experiments with this respiration calorimeter already made with men have added important data to the knowledge of the laws of nutrition.

Other studies have had to do with the substituting value of different nutrients and the proper combination of nutrients in the diet. Many dietary studies have been made with men and animals under different conditions and performing different amounts of work in various regions of the United States. A number of stations have made digestion experiments with men and animals, and the coefficients of digestibility for a considerable number of American foods and feeding stuffs have been worked out as the result of these experiments. Studies of the effect of different feeding stuffs on production of lean and fat meat have been made. In connection with nutrition investigations the composition of many American foods and feeding stuffs has been learned. The effect of cooking on different foods and the losses during cooking have also received attention. Much time has been devoted to the elaboration of experimental methods, the testing of methods already known, and the devising of new methods.

In zootechny (in the restricted sense of animal production), the work of the American stations has principally consisted of feeding experiments with different kinds of farm animals, in which various combinations of feeding stuffs have been tested with reference to the maintenance, growth, or the production of meat or milk. In this way the nutritive value of a large number of different kinds of American feeding stuffs has been worked out, largely on a practical basis. Important studies have been made on the nutritive value of crops of recent introduction, or crops which have recently assumed importance.

Digestion experiments have been conducted with horses, cattle, sheep, goats, and pigs. Attempts have been made at several of the stations to formulate feeding standards more suitable for American conditions than the German standards commonly in use. Tests of breeds of different kinds of animals have also been made, sometimes on a relatively large scale, and studies of types of animals best adapted to particular purposes have in some cases been made. The studies in zootechny have, to a considerable extent, been connected with the investigations in animal physiology.

In veterinary science, besides studies in bacteriology above referred to, investigations regarding the causes, nature, and treatment of various diseases of domestic animals have been made at the stations.

In agrotechny (agricultural technology), the most important work of the American stations has related to dairying. Besides the chemical and bacteriological studies of milk and dairy products referred to under the head of chemistry and bacteriology, the stations have made many studies relating to the methods of manufacture of dairy products.

Various kinds of dairy and creamery apparatus have been tested to a considerable extent, and in some cases demonstrations have been made of the method of conducting a hygienic dairy and milk route. Nearly every step in the handling of milk and in the manufacture of butter and different kinds of cheese has been investigated. In this connection they have done considerable work in studying methods of investigation and devising special apparatus and appliances for such work.

Other important investigations in agricultural technology have been those in sugar making by the Louisiana station, in the manufacture of wine and olive oil by the California station, and of vinegar and fruit sirups by the Virginia station. In these investigations the devising of new methods of manufacture and special apparatus and appliances have received large attention.

The American stations have as yet given comparatively little attention to problems in rural engineering. Studies of the form and construction of barns, silos, and other farm buildings have been made, as well as of the construction and heating of greenhouses and the construction of cheese-curing rooms cooled by natural means. Questions relating to methods of drainage and irrigation have been studied. The draft of farm vehicles, especially as related to the comparative merits of broad and narrow tires, has been tested. A considerable number of practical tests of implements and machinery used on farms or in dairying have been made.

VERIFICATION AND DEMONSTRATION INVESTIGATIONS.

A considerable share of the work of the American stations has thus far consisted of the verification of the results obtained at the stations or elsewhere and the demonstration of the practical usefulness of these results. This work has been partly carried on at the stations, more especially on the farms under their control, and partly by experiments in different localities, largely with the cooperation of farmers. This demonstration work has included a wide range of subjects along most of the lines in which the stations have attempted more original investigations. Attention can be called in this general statement only to some of the larger enterprises of this kind in which the stations have engaged. Of this character, have been very many of the experiments with fertilizers, thousands of which have been carried on in the States east of the Mississippi River.

A very large number of practical tests of different field crops and horticultural plants have also been made by the stations in cooperation with the farmers after the stations had determined on a small scale the adaptability of these varieties to the regions in which they are located. Many of the experiments in the feeding of animals and in dairying have been made by the stations for the purpose of confirming the results obtained through previous investigations in this country or abroad. Often the chief purpose of these investigations has been to convince the farmers that the results which have been obtained elsewhere were equally applicable to their local requirements. In a similar way, many investigations along the lines of chemistry, botany, entomology, and veterinary science have been repeated at the stations, either for the purpose of more firmly establishing the correctness of the results previously obtained or of showing the farmers that these results could be successfully applied in practice. Thus, many means for the repression of insect pests and the diseases of plants or animals have been tried over and over again by the stations and among the farmers until they have become a part of regular agricultural practice, at least among the more progressive portion of the agricultural community. For purposes of verification or demonstration, thousands of cooperative experiments are now annually carried on in the United States, in which the farmers take part under the direction of the stations.

STUDIES OF NATURAL AGRICULTURAL CONDITIONS AND RESOURCES.

Closely united with the demonstration experiments of the stations have been those studies which have primarily had for their object the gaining of definite information regarding the natural agricultural conditions and resources of the different States. While the stations were not established for the making of agricultural surveys or the collection of agricultural statistics, yet in many cases, especially in the newer States and Territories, in the absence of accurate information acquired through other agencies, it has been necessary for the stations to do more or less work of this character as a preliminary to the scientific investigations and practical experiments which it is their real business to make.

In this way the stations have in the past done considerable work in the collection of general meteorological data, sometimes in cooperation with State weather services and the United States Weather Bureau. This work has, however, now been given up for the most part, and the stations are confining their meteorological observations to those taken on their own grounds. In a number of States data regarding the geologic formations and soils in different localities have been obtained, and in a few States this has been done with sufficient thoroughness to enable the station to make a soil map of the whole State, or of particular agricultural regions. Studies of the nature of the water supply available for household use, for live stock, or for irrigation, have engaged the attention of a number of stations. There has been a considerable number of botanical surveys for the purpose of obtaining information regarding the native forage plants and fruits of different States, which might be utilized for economic purposes.

Several stations have done some work on the study of life zones of their States and the suitability of varieties of crops to these zones. The largest enterprise of the stations which may be said to have been essentially a study of the natural agricultural conditions has been the determination of the regions in which sugar beets may be grown with a sufficiently high percentage of sugar to make it probable that they might be utilized in sugar making, provided the economic conditions were favorable. This investigation was carried on by the stations very largely in cooperation with the Department of Agriculture and farmers. Thousands of experiments were made for several years, covering the entire country, and in this way the capabilities of the United States with reference to the growing of sugar beets were quite definitely established.

The marl and phosphate deposits have been investigated in a number of States, with reference to their use for fertilizers where conveniently located.

In several States, legislatures have made special appropriations to the stations for studies of the agricultural resources of particular sections as yet undeveloped or for overcoming natural obstacles to cultivation.

INSPECTION WORK OF THE STATIONS.

The experiment stations in thirty-six States and Territories are doing more or less work of inspection, either under special State laws or as a voluntary enterprise. The nature and amount of this service varies very greatly in different States. Sometimes the station conducts a complete inspection and control, sometimes it makes the chemical or other examinations on which control is based, and sometimes it simply makes the examinations and publishes the results for the information of the public, no system of control being provided by law. The fertilizer inspection and control was the first established in this country, is most extensively and thoroughly organized, and is most intimately connected with the work of the stations. More recently inspection of dairy products and other foods for man has been undertaken in a number of States, and the stations have been called upon in various ways to promote this work. In some of the Eastern States where concentrated feeding stuffs are largely used, laws for their inspection by the stations have been enacted within the past few years. Inspection for the prevention of diseases of animals and plants and the repression of injurious insects (especially the diseases and insect pests affecting nursery stock) and weeds has been begun in a number of States. Dairy apparatus and Paris green are required to be inspected in a few States, and there has been considerable voluntary inspection of seeds by the stations in different parts of the country.

The Hatch Act makes no provision for regular inspection work by the stations. The stations supported exclusively by this fund have therefore undertaken such work only incidentally with a view to showing its usefulness. Wherever it has assumed importance and the necessity for its regular performance has been made apparent, the States have made provision for its maintenance. Naturally the laws and regulations regarding this kind of inspection have varied with local requirements and opinions. In recent years there has been an increasing tendency toward greater uniformity in the general features of inspection laws and regulations.

DISSEMINATION OF INFORMATION BY THE STATIONS.

The Hatch Act requires that each station shall publish bulletins or reports of progress at least once in three months, and a full and detailed report of its operations, including a statement of receipts and expenditures, once a year. Most of the publications of the stations may therefore be divided into two general classes—annual reports and bulletins.

The annual reports of the stations vary greatly as regards the character of their contents, their size, and the number of copies printed. In a number of States the annual report is a large document containing a detailed account of the investigations of the station, as well as statements regarding its administration and finances. In some States it is a brief document containing only short statements regarding administrative matters, finances, investigations, and publications.

The bulletins of the stations are of different descriptions and can not be definitely separated into classes. Each of the stations has, however, a regular series of bulletins, usually numbered consecutively, which comprises the greatest part of its publications. These bulletins contain a great variety of information. Some of them consist wholly of compiled matter, some are popular accounts of station investigations, and others contain quite technical and elaborate descriptions of their investigations. Some stations have attempted to separate their technical and popular bulletins into different series and in some cases new series have been begun after the station has been in operation a number of years. As a rule, however, the stations issue their regular bulletins in a single series. Illustrations are quite generally used in bulletins, and more attention has been given from year to year to improving the general appearance of the bulletins.

Many of the stations annually issue more than the four bulletins required by the Hatch Act. The bulletins are sent out to mailing lists containing from 3,000 to 35,000 addresses in different States, the aggregate number of addresses being about half a million. The stations endeavor to send their bulletins to all applicants within their own States and to satisfy outside demands for them as far as their means will allow. This outside demand has, however, grown to be so large as already to cause embarrassment. Each station has a considerable number of foreign correspondents to whom the bulletins are regularly sent.

In a number of the States the stations prepare press bulletins, which are either résumés regarding the station work or contain information of more general character. In cases in which the station receives a large number of requests for information on any topic it has been often found convenient to have answers distributed through the press rather than by correspondence.

Some of the stations have issued charts and posters illustrating special features of their work.

Station officers participate to a considerable extent in the meetings of farmers known as farmers' institutes, which are now regularly held in forty-three States and Territories, principally during the winter months. It is estimated that there are now annually held in the United States some two thousand institutes, which are attended by about half a million farmers. Through the institutes the stations are therefore able to largely supplement their publications by oral explanation of their work to large numbers of farmers. Station officers also make a large number of addresses each year before State and local agricultural, horticultural, and dairy associations and miscellaneous meetings of farmers. The correspondence carried on by station officers is very large, aggregating hundreds of thousands of letters annually. A large part of these are replies to inquiries by farmers, which cover almost every topic relating to the theory and practice of agriculture. A considerable number of stations make exhibits of their work at State and other agricultural fairs.

GENERAL RESULTS OF THE WORK OF THE STATIONS.

During the past ten years more than $10,000,000 have been expended for the maintenance of agricultural experiment stations in the United States. Of this sum, about $7,000,000 came from the Federal Government and $3,000,000 from State sources. During that time the United States produced agricultural products valued at thirty thousand million dollars. The maintenance of the stations therefore involved the expenditure of $1 for every $3,000 worth of agricultural products. Considered in this light the funds used to improve the quality and increase the yield of our agricultural products do not seem disproportionately large. They are, however, sufficiently large to make it very important that the results shall clearly justify the continued expenditure of such great sums for the support of the stations.

Many of the results obtained in experimental inquiries in agriculture are of course of such a character that it is difficult, if not impossible, to give any exact measure of their value, especially on a financial basis. A large share of the work must necessarily give negative results, the practical value of which consists in showing the farmer the things which he ought not to do. Obviously many of the results which have a limited or local value, and which in the aggregate would go far toward justifying the maintenance of the stations, can not even be referred to in a summary statement like this. We shall, however, attempt to call attention very briefly to some of the more prominent results which the stations have obtained and on which their claims of usefulness to our agriculture must depend.

INTRODUCTION AND DEVELOPMENT OF AGRICULTURAL METHODS, CROPS, OR INDUSTRIES.

Beginning with the work of the stations in which the attempt has been made to introduce or develop new methods, crops, or industries, we may with good reason assert that the most important general result of experiment-station work has been along the line of dairying. The working out of practical methods and apparatus for the rapid determination of the fat content of milk, most perfectly accomplished by the Wisconsin station; the researches regarding the chemistry and bacteriology of milk and dairy products, the elaborate investigations on cheese making at the New York station, and on the ripening of cheese at the Wisconsin station; the more practical experiments in butter making at the Iowa station—these and other investigations at the stations, combined with the dissemination of information regarding the results of work in similar lines abroad, have brought about a widespread revolution in the business of dairying in this country.

Closely connected with the improvement of dairying have been the investigations on nutrition, many of which have been directly made with dairy cattle. These have had to do with the effects of feeding stuffs on the quality of milk and the character of butter or have dealt with the economical production of dairy products. The highest point in the work on nutrition has been reached in the perfecting of methods and apparatus by the Connecticut Storrs station in cooperation with this Department. The respiration calorimeter devised at that station, having proved its usefulness in investigations on some of the fundamental problems of the nutrition of man, is now being adopted by the Pennsylvania station and the Department to use in similar investigations with farm animals. Two European governments have made liberal appropriations for the construction of respiration calorimeters after the plan of the Connecticut apparatus.

The Iowa, Maine, Massachusetts, Michigan, Minnesota, New York, Pennsylvania, Vermont, Wisconsin, and other stations have also made important investigations on the nutrition of dairy and other farm animals, which have widely changed the practice of feeding such animals. Among such investigations are those relating to the effect of the character of the food on the quality of the product and on the proportion of fat and lean meat in steers and pigs; the suitability of breeds of animals of different conformation to various purposes; effect of shelter and treatment on growth and gain, and the economy of a large number of different feeding stuffs, representing those generally at the disposal of the farmers; the effect of cooking and other methods of preparation. One very important result, on account of the enormous supply, has been the demonstration of the feeding value of corn stover when properly cared for, and the intrinsic feeding value of different by-products of wheat.

Notable instances of the successful introduction of new crops are the Manshury barley by the Wisconsin station, which has materially increased the yield of barley over a wide region, with results worth millions of dollars, and the Kafir corn brought in by this Department, but introduced to practical use on a large scale by the stations in California, Kansas, and Oklahoma, the crop being valued at about $6,000,000 in Kansas alone in 1898. The Minnesota and Wisconsin stations were instrumental in the introduction of rape as a forage plant for sheep, and it is now grown on thousands of farms in the Northwest to the great advantage of the farmer. The hairy vetch, introduced by the Mississippi station, has proved of great value to that State.

Important studies on the nutritive value and practical usefulness of alfalfa (lucern) by the Colorado, Utah, and other Western stations have done much to extend the area and enhance the value of that crop in the irrigated region, while recent experiments by the New York and New Jersey stations and a number of stations in the Gulf States seem to indicate that it has a wider usefulness in the East than has hitherto been supposed. The value of crimson clover as a crop for forage and green manuring over a considerable area has been shown by the Delaware and other stations. The investigations on sugar beets conducted throughout the country by the stations and this Department have already had a practical outcome in the successful establishment of sugar factories in several States, and have shown in a very definite way in what regions this industry has the best chance of success. The work of the Louisiana station on methods and apparatus for making cane sugar and on the culture of the sugar cane have been so far successful as to secure for the station the financial support of the State Sugar Planters' Association.

The staple crops of the country, as maize, wheat, cotton, and tobacco, have been the subject of an immense amount of investigation touching nearly every phase of their chemical composition, improvement by breeding and selection, culture, manuring, harvesting and curing or storage. Many of the results have been of direct practical value and have materially influenced the methods followed by farmers. These investigations have also led to a greater diversification of agriculture in many regions.

The investigations which a number of our stations have made regarding the storage of forage crops in silos and the use of silage for feeding purposes have been of great importance in connection with the development of dairying in this country. These have related to the methods of constructing and filling silos, the best time for cutting the crops to secure the maximum amount of nutrients, increasing the richness of the silage by adding leguminous crops, and the feeding of the product. The results of the investigations on silage have done much to promote economy of production in dairying. The investigations of the Illinois, Ohio, Indiana, and other stations, which demonstrated the superiority of shallow over deep cultivation of maize, have produced widespread changes in the culture of that crop.

The stations have performed a very extensive and useful work relating to the use of commercial fertilizers. This is a subject of great economic importance in almost all the States east of the Mississippi River. The investigations of the stations have shown the fertilizer requirements of different soils and crops and have led farmers quite generally to recognize the desirability of a discriminating use of fertilizers. More recently the stations have shown the feasibility and general advantages of the home mixing of fertilizers by the farmers themselves.

In the States west of the Mississippi River the conservation of moisture in the soil is an important factor in successful agriculture, and the stations in that region have done valuable work in showing the conditions under which the moisture is largely conserved, and by introducing methods of tillage especially adapted to this purpose.

The investigations which the California station has made regarding alkali lands have led to the reclamation of large tracts of land in that State, which before were thought to contain alkali in such amounts as to make them useless for agricultural purposes.

Among the horticultural investigations of the stations which have given the most important practical results are those relating to the introduction of new kinds and varieties of fruits in different localities; the increase of hardness and resistance to disease by grafting; the culture and management of orchards; the storage of fruits, and the heating and subirrigation of greenhouses. Those investigations which have related especially to the forcing of vegetables in the field and under glass have been a considerable factor in the rapid development of the business of supplying markets in the United States with a large amount of green food at all seasons of the year, even in the States farthest North.

The work of the California station with reference to the culture of grapes and olives and the manufacture of wine and olive oil have proved a great aid to the development of the wine and olive-oil industries in that State.

REMOVAL OF OBSTACLES TO AGRICULTURAL INDUSTRIES.

The American stations have done a great work in aiding the farmers in their contest with the natural enemies to successful agriculture and in removing, in whole or in part, obstacles which hinder the progress of various agricultural industries. Under this head, the most important investigations of the stations have been those relating to insect pests and diseases of plants and animals.

The following examples of work in entomology conducted by the stations, which have been of great economic importance, may be cited. Much has been done in the development of effective means for the repression of such insects as the codling moth, plum curculio, chinch bug, Rocky Mountain locust, woolly aphis, cottonworm, cotton boll weevil, San Jose scale, forest insects, and insects affecting stored grain. Experiments with such insecticides as bisulphid of carbon, hydrocyanic-acid gas, petroleum, kerosene emulsion, Paris green, London purple, pyrethrum, and hellebore have brought out many useful facts regarding the best ways in which to use these materials in combating injurious insects. Much attention has been devoted to the study of spraying apparatus, and various improvements in spraying devices have been suggested by the stations, which have come into general use. Among the most successful investigations of the stations on plant diseases and their treatment have been those relating to diseases of potatoes, cotton, cereals, sweet potatoes, beans, asparagus, celery, pears, and grapes.

Among animal diseases, the work of numerous stations on tuberculosis has had widespread practical results. The methods of application and the limitations of the tuberculin test have been thoroughly and widely studied. Much attention has been given to the prevention of hog cholera, using the serum made by the Department of Agriculture, and also a somewhat different one worked out at the Nebraska station, which is believed to reduce the percentage of infection very materially.

Many experiments have been made in rendering animals immune to Texas fever when taken into the region where it prevails, for breeding purposes or for grazing, and in preventing the spread of the disease to new regions through the movement of cattle. The source of infection of anthrax in Delaware has been traced to the pollution of streams with the wash water from morocco tanneries, and much effective work has been done in the repression of this disease in that State.

DEFENSE OF THE FARMER AGAINST FRAUD.

As stated elsewhere, the stations east of the Mississippi River have been largely engaged in the control of commercial fertilizers. The fertilizer business in this country involves millions of dollars, and the stations have largely prevented the sale of fraudulent goods. The stations have also done much to expose extravagant claims made for commercial fertilizers as compared with farm manures. More recently the stations in a number of States have been engaged in the inspection of feeding stuffs, dairy products, and nursery stock for fungous diseases and insect pests. Besides the prevention of fraud by a regular system of inspection, the stations have also done much useful work in this line in other directions. For example, their tests of varieties of grain, vegetables, fruits, etc., have often shown farmers how extravagant were the claims made for new varieties of plants. Their tests of the purity and vitality of seeds, while not systematically conducted, have yet done much toward making the farmer more careful in his purchases of seeds. From time to time the stations have exposed frauds relating to the sale of quack medicine for stock, creamery construction and equipment, dairy products, butter increasers and preservatives, adulterated foods and feedings stuffs, etc.

AID TO THE PASSAGE OR ADMINISTRATION OF LAWS FOR THE BENEFIT OF AGRICULTURE.

The experiment stations, as well as the agricultural colleges, have been largely instrumental in securing and administering State laws for the inspection of fertilizers, nursery stock, dairy products, foods and feeding stuffs, creamery glassware, and Paris green; and for the suppression of plant diseases and injurious insects. They have also aided in the passage of laws establishing farmers' institutes, organizing associations for the promotion of agriculture, fixing a milk standard, quarantining animals for contagious diseases, regulating the sale of oleomargarine and kindred products, determining the apportionment and measurement of water for irrigation, securing the improvement of roads, etc.

EDUCATIONAL RESULTS OF STATION WORK.

Broadly speaking, the most important results of the work of the American stations during the past quarter of a century, and especially during the past decade, have been educational. As we have seen, they have distributed very widely in their own publications a vast amount of accurate and valuable information regarding the theory and practice of agriculture, and have thus directly contributed on a large scale to the technical education of farmers. As the result of the investigations and publications of the stations, the agricultural books and the agricultural journals published in this country have been largely revolutionized. Instead of depending as formerly almost entirely on foreign agricultural literature as the standard for agricultural theory and practice, we have now a considerable body of distinctively American agricultural literature. If we contrast the meager amount of up-to-date information on matters connected with his art which was available to the American farmer ten years ago with what we now possess, we will without doubt be convinced that as educating agencies the experiment stations have been a great success. No nation has ever attempted the free dissemination of agricultural information in so wide and thorough a way as has the United States, and it is believed that the results have justified the large expenditures which have been made for this purpose.

One large result of the educational work of the stations has been the general breaking down of the popular conception that agriculture is not capable of improvement through systematic and progressive researches in its behalf conducted on scientific principles. A widespread belief has been awakened that with the aid of science agriculture may be so lifted out of the ruts of a dead past that it will be able to hold its own amid the growing competitions and complexities of modern civilization. Some of the consequences of this new belief are likely to be very important and far-reaching. Already the farmer in this country is much inclined to demand that theories and assertions regarding the practice of his art shall be brought to the test of rigid and accurate investigation. Those who have in recent years followed up the agricultural press or the farmers' institutes, testify that articles or speeches which simply declare individual opinions or individual experience no longer satisfy the farmer.

Whenever new ideas or theories are brought to the attention of the farmer he is very apt to inquire if the experiment stations have looked into this matter, or he will at least demand that some sort of positive proof shall be presented that it is wise for him to accept the new proposition. While there has been at times widespread discontent among the farmers with regard to their economic condition, it may also be said that the experiment stations have done much toward inspiring a feeling of hopefulness. The stations are not only giving the farmer much information which will enable him to improve his practice of agriculture, but they are also leading him to a more intelligent conception of the problems with which he has to deal and of the methods he must pursue to successfully perform his share in the work of the community and hold his rightful place in the Commonwealth.

As regards the stations themselves, we may confidently assert that their past history gives great assurance of increasing strength and efficiency in the future. While they have encountered many difficulties in their development, and there has necessarily been much crudity in their work thus far, they have every year secured a better equipment and more thoroughly trained officers. With increasing resources they have been able to specialize their work more thoroughly and to increase its scope. They have succeeded in securing to a remarkable extent the confidence of the people for whose benefit they were primarily established, and have thus had no difficulty in obtaining financial support from Congress and the State legislatures. The people generally have come to regard the stations as permanent institutions and are convinced of the usefulness of their work. They will therefore enter upon the twentieth century with bright prospects for the development of their researches in scientific thoroughness and accuracy and for the securing of larger practical results.

SEED SELLING, SEED GROWING, AND SEED TESTING.

By A. J. Pieters,

In Charge of Pure Seed Investigations, Division of Botany.

INTRODUCTION.

The history of the development of the seed business of the country is one of the most interesting chapters in American horticulture. From small beginnings in the later colonial period the business has grown so that to-day its value is measured by the tens of millions. Carried on at first in small shops, where a few boxes of seeds shared a corner with codfish or a shelf with calicoes or books, it has come to claim for itself immense warehouses and business establishments whose interests extend to every portion of the globe. The trade has grown with the growth of the country; and its leaders have influenced popular taste for good vegetables and fine flowers, creating and stimulating a demand which only their enterprise could suffice to meet.

When the Pilgrims landed on the rocky shores of Massachusetts they brought with them seeds of the plants they had cultivated in their English and Dutch homes. Their first care was to secure the necessaries of life; corn, barley, and peas were planted and fruit trees set out. The early records of horticulture are almost entirely devoted to the discussion of fruits, the introduction of improved varieties of apples, pears, and plums occupying a much larger share of attention than the improvement of vegetables. The latter were, however, only second in importance to indian corn. William Wood gives a list of vegetables grown in New England before 1633, and adds "whatever grows well in England grows as well there, many things being better and larger." A century later there is a distinct reference to saving garden seeds. Justice Dudley, of Massachusetts, writing in 1733, says "an onion set out for seed would rise to 4 feet 9 inches, and a parsnip would reach 8 feet." Some agricultural seeds were certainly raised, and they formed an article of commerce as early as 1747. In his interesting book on "Farm husbandry" the Rev. Jared Eliot has much to say about clover, and in the first essay published, 1748, he urges the liberal use of seed because an acre of clover will produce 2 bushels of seed worth 35 pounds, "Old Tenor."[1] That clover seed was

[1] The colonial currency was of three values, and was known as "Old Tenor," "Middle Tenor," and "New Tenor;" the "Old Tenor" was below par, but the rates varied in different colonies.

not abundant, however, is shown by the high price and the fact that in 1773 James Vaux, of Pennsylvania, imported some from England, because it was difficult to get in America. In 1787 Vaux, in a paper before the Philadelphia Society for the Promotion of Agriculture, advocated a bounty on clover seed in order to encourage its use by reducing the price.

SEED SELLING.

DEALERS PREVIOUS TO THE COMMENCEMENT OF THE PRESENT CENTURY.

The first record of seeds for sale that the writer has been able to find is in the Newport, R. I., Mercury of 1763, where Nathaniel Bird, a book dealer, advertised garden seeds just arrived from London. Connecticut-grown onion seeds early acquired more than a local reputation. In 1764 Gideon Welles, "on the Point," announced in the Newport Mercury that he had some choice Connecticut onion seed for sale. Other advertisements ran through the following years, among them one by Charles Dunbar, gardener. We get some idea of the prices of seeds from Dunbar's advertisement of 1767, where the following are given: Peas and beans, 30 shillings[1] per quart; Strasburgh onions and orange carrots, 25 shillings per ounce; early cabbage, 40 shillings per ounce, and "colliflower," 6 pounds per ounce. An N. B. informs us that "said Dunbar has to sell a great variety of flower seeds."

In New York City hemp and flax seeds were advertised for sale at least as early as 1765 and garden seeds in 1776. In that year Samuel Deall, a dealer in general merchandise on Broad street, opposite the end of Weaver street, kept "a general assortment of seeds," many of which he names, including red clover, grass, and "Saintfoine" for improvement of land.

In the New Hampshire Gazette field seeds were advertised as early as 1766 and garden seeds in 1770. But Boston was the chief city for the sale of garden seeds, as it was the commercial center of the time. In the Boston Gazette of 1767 six out of twenty-six advertisers were dealers in seeds. Some of these did not advertise other goods, but it is doubtful whether they were seed dealers exclusively. In the spring, when these advertisements appeared, the trade in seeds was probably more important than any other branch of their business. Some of these dropped out and others appeared in later years, but several advertised regularly each year until 1773.[2] William Davidson, the gardener in Seven Star Lane, offered in 1768 seeds of 56 varieties of vegetables and herbs, and of one flower, the carnation. Some of

[1] The value of the currency had fallen so low that in 1759 it required 2,300 pounds in currency to equal 100 pounds sterling; these conditions were only beginning to improve in 1767.

[2] In the file accessible to the writer there is a break here, the next number being in 1777.

his prices were as follows: Lettuce, 3 to 4 pence per ounce; cabbage, 9 pence to a shilling per ounce; cauliflower, 3 shillings per ounce; carnation, 4 shillings per ounce. Most of the other vegetable and herb seeds ranged from 2 pence to a shilling per ounce; peas, Early Golden Hotspur and Early Charlton, were worth 24 shillings the bushel or 10 pence per quart. Davidson dealt in seeds wholesale and retail for cash.

The war of independence, interrupting as it did the regular channels of trade, interfered with the importation of seeds, and the few garden seeds offered during this time were either imported from Holland or were taken from prize ships. Immediately after the war there was a revival of the trade in seeds, and in 1784 John Adams, Susanna Renkin, and Susanna Martin all advertised seeds just imported from London. These advertisements, however, soon after ceased, and in 1790 John Adams advertised for the last time in the Boston Gazette. It is not to be supposed that the absence of advertisements indicates the total cessation of the trade in seeds. This either flowed in other channels or the traders lost enterprise. But with the advertising habit well formed as it was prior to 1770, the total absence of advertisements of seeds for sale certainly indicates an unhealthy condition of the trade.

In Philadelphia and New York seeds were but little advertised, whatever the trade may have been. In Philadelphia in 1772 Peteliah Webster sold clover and duck grass seed, and in 1775 James Longhead made known to the public that he kept "a quantity of the largest kind of colly-flower seed, found on trial to be extraordinary good." In 1775 David Reid, who styled himself "Gardener and seedsman," advertised seeds for sale at his stall at the courthouse, and in 1781 purchasers were advised that flower seeds and seeds for the kitchen garden, "imported from Holland, can be procured next door to General Philip de Haas, in Third street, near Race street."

During the remaining years of the eighteenth century the papers contained few advertisements of seeds, and we can trace no connection between dealers of pre-Revolutionary times and those of the opening years of the nineteenth century. It is not probable, however, that there was a time when seeds could not be bought in any of the large towns. The people were fond of gardening, the population was rapidly increasing, and there is no reason to suppose that the demand for garden seeds was less than before the war. This demand was doubtless partly supplied by the market gardeners, one of whom, David Landreth, established himself in Philadelphia in 1784, and engaged in the market gardening, nursery, and seed-growing business. The last was at first of small importance, and for many years the nursery occupied most of his attention. Seeds were almost entirely imported, and American gardeners had yet to learn that seeds could be as well grown here as in England. In spite of this, however, the seed business seems to have increased in importance until, in 1848, David Landreth, jr., sold the nursery and became exclusively a seed grower and merchant.

THE TRADE DURING THE FIRST HALF OF THE CENTURY.

One of the first seedsmen of the present century was Bernard M'Mahon, gardener, seedsman, and author, who in 1800 opened a seed store in Philadelphia. Fortunately, we have a description of his store, which throws light on the condition of the trade at that time:

His store was in Second street, below Market, on the east side. Many must still be alive who recollect its bulk window, ornamented with tulip-glasses, a large pumpkin, and a basket or two of bulbous roots. Behind the counter officiated Mrs. M'Mahon, with some considerable Irish accent, but a most amiable and excellent disposition, and withal an able saleswoman.

Mr. M'Mahon was also much in the store, putting up seeds for transmission to all parts of this country and Europe, writing his book, or attending to his correspondence, and in one corner was a shelf containing a few botanical or gardening books, for which there was then a very small demand; another contained a few garden implements, such as knives and trimming scissors. a barrel of pease, and a bag of seedling potatoes, an onion receptacle, and a few chairs, and the room partly lined with drawers containing seeds, constituted the apparent stock in trade of what was one of the greatest seed stores then known in the Union, and where was transacted a considerable business for that day.[1]

In the fall of 1805, Grant Thorburn began to sell seeds in New York, and subsequently built up a substantial business. During the next quarter century seed stores were opened in Baltimore, Boston, and Charleston, S. C., as well as in Philadelphia and New York, and there was a considerable trade in Shakers' seeds. These Shakers' seeds were popular as early as 1818. They were sold by regular dealers, and were peddled about the country in the Shakers' wagons. The population of the United States had increased from a little more than three millions of whites in 1790 to ten and a half millions in 1830. In 1790 this population was practically confined to a narrow strip along the Atlantic seaboard. Forty years later it had overflowed into the rich valleys beyond the mountains.

To meet the growing demand for vegetables and flowers, these ten and a half millions required more than three and a half times as many seeds as were used in 1790. Dealers established themselves in the principal cities and crossed the Alleghenies in the rear of the wave of settlement that swept into the Ohio Valley. The large cities became centers of distribution for the surrounding country, but the trade remained essentially local, though the larger houses did a wholesale business and supplied country dealers with their stocks, put up in packets for the retail trade. But transportation was slow and expensive, and the modern development of the postal service was as yet undreamed of. The amount of seed sold in Ohio at this time was insignificant. Mr. Parsons Gorham, a grocer and seed dealer in

[1] The American Gardener's Calendar, eleventh edition.

Cincinnati between 1827 and 1831, seldom carried a stock of more than 50 bushels of grass seed; and when, in 1831, S. C. Parkhurst opened a seed store, he sold in one year not more than 600 bushels of timothy and clover seed, while before the end of ten years his trade had increased to 6,000 bushels. Seed houses were opened in Mobile and New Orleans, and in 1844 William W. Plant began the sale of farm tools and seeds in St. Louis.

While most of the trade between 1820 and 1850 was local or wholesale to country dealers, a change took place with the advent of the locomotive. The larger houses reached out for wider fields, made accessible by the railways, and new firms sprang up in every city of considerable size. Locomotives were unknown in the United States before 1829 and were scarcely used before 1832. At the end of 1835 there were 1,098 miles of railway in the United States; in 1850 the total mileage was 9,021, and in 1860 it was 30,635.

This rapid increase in the railways not only opened up a vast and flourishing country, but facilitated transportation in the East and made possible the immense development of the mail trade. The mails brought the seedsman to every door; a letter brought a catalogue, and a few cents paid the postage on an order of seeds. The changes in the rates of postage and the regulations of the post office have at times helped or embarrassed the trade; but, though cheap postage has stimulated, higher rates have never checked the growth of the business.

DEVELOPMENT OF THE SEED CATALOGUE.

Along with the reaching out for trade beyond the limits of the home city came first the increasing size and prominence of the catalogue, and soon after a more attractive method of advertising. Seed catalogues were offered at least as early as 1805, but these were mere lists and were not intended for general distribution. For forty years most of them remained essentially price lists, and were offered only as an afterthought in an advertisement. Grant Thorburn's catalogue is, so far as the writer knows, the only one issued in pamphlet form as early as 1823. In 1825 his little book of about 4 by 7 inches in size contained 87 pages. Besides the usual retail price list, there was a wholesale list, and catalogues of bulbs, of flowering plants, and of tools. Brief directions for planting were given, and there were some longer articles on the culture of special grasses.

Shortly before the civil war the catalogue became more prominent. It was increased in size and issued in pamphlet form. The varieties offered were more or less carefully described, cultural directions were given, and an almanac and calendar of gardening operations was a frequent and prominent feature. A few illustrations appeared before 1867, but after that date their number steadily increased, and before 1870 colored plates were introduced.

There have been changes in the advertisements in some respects similar to and in others quite different from those which have taken place in the catalogue. The old advertisements contained long lists of varieties, with prices, and differed little in type and style from the body of the paper, though sometimes more striking headlines were used. Gradually the advertisement was decreased in size, but was made more striking to the eye, and the announcement of the new catalogue occupied a prominent place. About 1870 the advertisements began to be more fully illustrated with cuts of those vegetables and flowers to which special attention was called. From this time on the style of advertising changed rapidly, always tending toward larger headlines, more illustrations, and such devices of the printer's art as would most surely catch and hold the reader's attention.

The early garden calendars were designed largely for distribution by the country dealers, who bought the seeds at wholesale. There was as yet but little direct contact with the distant consumer, as the mail trade was in its infancy. But with the increase of the postal facilities dealers began to depend more upon their catalogues. The offer to send catalogues free became a prominent part of a seed advertisement, and every effort was made to render the catalogue attractive. Year by year the illustrations increased in number and quality, and pages of useful information gave it some title to rank as a garden guide.

Novelties were not so numerous twenty years ago, and they did not receive the prominence the modern catalogue accords them. Before 1880 a special place in the seed catalogue was not generally given to novelties. Some firms gave prominence to new varieties, but many of the leading houses either ignored them or simply added to their regular list such as they found worthy. To-day, however, there is not an important catalogue but gives more or less space to novelties, and the descriptions of these are frequently printed on tinted paper or made attractive by devices of the printer's art. Some varieties remain in the novelty pages of one catalogue or another for years, and not infrequently a novelty will reach the age of two or three years in the catalogue of the same firm. Seedsmen are on the alert for novelties; they are the money makers, and, besides, every really good introduction extends the reputation of the introducers. Many of the new varieties drop out after a year or two, being found wanting in some important particular and unable to make head against the old favorites; but others have intrinsic merit, and it is by the addition of these that our horticulture is enriched. The success of a novelty may be said to depend largely upon the introducers, since reputable firms endeavor to place only approved sorts in their novelty list; and, although even they are sometimes mistaken, the varieties thus introduced are more likely to possess merit than those heralded as possessing all sorts of impossible qualities and overburdened with a profusion of adjectives.

The modern catalogue is the seedsman's agent. It tells the prospective customer of the business it represents, setting forth in an attractive manner the superior merits of the seeds it offers. It must not only attract the eye, but must appeal to the judgment and to the imagination of the buyer. But the catalogue is more than the seedsman's agent—it is a text-book of horticulture. Millions of these illustrated catalogues find their way every year into rural homes. They are studied and compared, and much of the amateur gardener's knowledge of varieties is obtained from the seed catalogues. It is highly important, therefore, that the catalogue should be honest; it is perhaps too much to ask that it be conservative. The pictures should be as honest as the text, since the good effects of an accurate description may be ruined by an exaggerated illustration. Nor would honesty in text and figure exclude the proper praise of meritorious varieties; on the contrary, figures that are clearly not overdrawn and descriptions at once terse and complete will do more than the extravagant use of adjectives to inspire confidence, both in the qualities of the variety and in the seedsman's knowledge of them. Fortunately, most of our large houses do not seriously transgress in this matter; but there are some that do, and many irresponsible firms seem to think that they can make up in printer's ink what they lack in experience and reliability.

It would doubtless be difficult to say how many well-edited catalogues are published in the United States. Seedsmen would naturally differ in their judgment. In good catalogues two things are accomplished—the varieties are carefully described and so arranged that the purchaser can readily find what he wants. These catalogues describe in a few words the essential characteristics of the varieties, and in many cases these are grouped, as with cabbages, into first or early, second or summer, and late or autumn sorts; or with lettuce, as heading or not heading, and Cos varieties, for forcing or outdoor culture, and spring and summer varieties. This grouping is of great assistance to purchasers unfamiliar with the varieties described, helping them to select the sorts best suited to their location and needs.

Naturally, many more varieties are offered than are desirable in one garden. Some of these would be better left out, but they are popular in certain places and must be offered to hold that trade. Others, again, do better in one section of the country than in another, while a third class are merely synonyms of other varieties also catalogued. It is the aim of every careful seedsman to weed the synonyms out of his catalogue as much as may be; but with the present total lack of system in horticultural nomenclature it is difficult to arrive at perfection in this matter. So long as anyone can change a name and thus make new varieties from old ones, or can add his name to that of an established variety, a large number of synonyms must be expected, nor can the student of horticulture ever be sure that varieties of the same name are alike. It is also true that seedsmen often feel compelled to list names they know to be synonyms because the variety is known and called for under that name. It would be better, however, to list the variety under its proper name and add the synonym if necessary.

A tendency in modern catalogue making that promises well for the future is the increase in the use of half-tone illustrations. Many of the leading catalogues are adopting this method of illustrating, and in some it has become a feature. The older woodcuts, as well as many of the exaggerated illustrations of to-day, have lost their power to charm and to deceive. The public wishes to know as nearly as possible what the seed will produce under favorable conditions; it is the real, not the ideal, that is wanted. The seedsman may strive for the latter in breeding up his variety, but while this ideal is still unrealized he should hold his imagination in check when deciding on the illustrations for his catalogue.

Summing up catalogue making, a writer a few years ago said:

> The work of compilation on the modern catalogue is thorough and exhaustive, calling for vast knowledge of every branch of trade and an intimate acquaintance with a fluctuating market. The arrangement for a thorough supply of the stock to be advertised, the ability called into play to gauge what all his rivals are going to push and the prices they will charge, marshaling order out of chaos, writing and telegraphing to every corner of the globe, watching the work on the illustrations, and scores of minor matters to be regulated, call into play faculties of superior order, and make many a man old before his time from the tension on the system in the getting out of the great annual catalogue.[1]

THE GROWTH OF SEED HOUSES.

The seed trade has changed quite as much as has the catalogue. The barrel of peas has grown to hundreds of bags, and the few thousand of packets to millions. The large modern seed stores, whether devoted to the local or to the mail trade, are models of convenience and of system. In most of them fanning mills of the monitor or clipper type are constantly employed in cleaning and grading seeds, and from the cellar to the mailing room everything is so arranged that orders may be filled with accuracy and dispatch. During the late summer and early fall the force is employed in addressing envelopes for catalogues and in packeting seeds in readiness for the busy months. In the order books there is an entry for every post office in every State, no matter whether an order has ever been received from that office or not.

Thirty years ago one hundred letters a day was considered a large business; to-day some houses receive over six thousand letters a day during the busy season. Firms that twenty years ago employed only one or two clerks now employ a hundred during the winter months. Throughout the West the seed business has flourished; a Wisconsin firm writes that its business has increased 500 per cent in the last fifteen years; a single warehouse of a Western firm now has between 7 and 8 acres of floor space.

[1] Florists' Exchange, March, 1895.

THE EXPORT TRADE.

That the growth of the trade during the century has been great scarcely needs emphasizing, but it is difficult to secure figures showing the rate of increase. Only a few seed houses antedate the civil war, and the great majority are of recent origin; the statistics of exports date from 1855 and no separate records of imports of seeds were kept before 1873. Clover and grass seeds, especially timothy, have always taken the lead in the seed export trade, and until recent years garden seeds have not been a considerable factor in the total values. In 1825 some 10,000 bushels of clover seed were exported to England within a few months. How long this trade had existed we do not know. From 1855 to 1864 there is no record of any seeds exported except clover, but the value of exports increased from $13,570 in 1855 to $2,185,706 in 1863, the war apparently having no effect on the trade. The total value of the clover seed exported during this period aggregated $5,393,663. During the decade ending with 1880 clover seed was not separately entered except in the last year, but the total exports of seeds amounted during that period to $20,739,277. The aggregate was increased by more than $3,000,000 before the end of 1890. From 1891 to 1898 there has been a slight reduction in the average annual value of seed exports and also in the amount of clover and timothy seed sent abroad.

SEED GROWING.

Before the beginning of the century only three seed farms had been established in the United States, though for many years seeds were grown by farmers and market gardeners. Home-grown clover and grass seeds, flax, hemp, and Connecticut onion seeds were on the market during colonial times, but the impression prevailed that garden seeds could not be successfully grown in America, and for the first sixty years of this century almost all the vegetable and flower seeds were imported. It was natural that clover and grass seeds of American origin should be offered earlier than garden seeds. The former grew freely throughout the colonies and produced seed in abundance, while it required special skill and care to raise good garden seeds. Eliot, in 1747, and Spurrier, in 1793, both refer to clover-seed and grass-seed crops, and describe methods of harvesting and cleaning. Nicholson, in the Farmers' Assistant, 1814, describes most of the grasses used to-day, and says that they seed freely. Flaxseed was an article of export at an early day, and a considerable quantity of clover seed was sent to England in the early years of the century.

ESTABLISHMENT OF SEED FARMS.

The present development of garden-seed growing began when David Landreth established a small seed farm at Philadelphia in 1784. At first but a few acres were cultivated, and these were mostly occupied by the nursery. As the business grew, more land was added, until in 1860, some 600 acres were under cultivation near Philadelphia alone. The Shakers, who came to America in 1774, began growing seeds at Mount Lebanon, N. Y., twenty years later. During the first quarter of the nineteenth century their seeds were more popular than any others, and outside of the large towns they supplied almost the entire demand. The well-known probity of these people and the excellent culture of their farms gave their seeds a wide reputation. Their wagons went from village to village, and they also sold on commission at 25 per cent, taking back the seeds that remained unsold. In 1839 the Shaker colony at Tyringham, Mass., devoted 4 or 5 acres to the cultivation of garden, medicinal, and herb seeds, and their annual sales sometimes amounted to more than $3,000. A seed farm was established at Enfield, N. H., in 1795, one in Connecticut between 1810 and 1820, and three more before 1830. Other seed farms existed for a short time, but were abandoned. The Clairmont seed gardens near Baltimore, Md., supplied some of the dealers of that city about 1851 and probably earlier. At a still earlier day there was a seed garden in New Jersey, on which Grant Thorburn spent his fortune between 1808 and 1813. Thorburn failed and temporarily retired from the seed business. Of the other seed farms in existence in 1890, thirteen were established between 1830 and 1840; fifteen between 1840 and 1850, and nineteen during the following decade.

RAPID INCREASE IN SEED GROWING DURING THE LAST FORTY YEARS.

The opening of the civil war found the country still largely dependent upon imported garden seeds. The heavy taxes and the premium on gold raised the prices of all imported seeds to such an extent that the dealers began to look anxiously for a home supply. During the first year of the war the trade in seeds fell off, prices were high, and seeds scarce. This condition stimulated home production, and as many seed farms were established between 1860 and 1870 as during the thirty years before the war. It was found that many vegetable seeds could be grown as well in this country as abroad, and that all kinds, for which the climate and soil were suitable, were much more safely grown under the eye of the dealer. Growers also became more expert, and market gardeners found that they could get as good seeds from the seedsman as they could save themselves, and at less than one-half the cost. The seed grower secured a critical and profitable trade, and the market gardener found a reliable source of supply for his seeds. This critical trade and the constant demand for better varieties stimulated the seed grower to do his best work. Seeds of the standard varieties were more carefully grown and new sorts, earlier, larger, or of better quality made their appearance every year. But it was by demanding reliable seeds rather than new varieties that the market-garden trade exercised the best influence upon the seedsman. To a man who expended annually $100 to $300 per acre for labor and fertilizers, it was of the utmost importance that his seed should produce exactly what he expected, and he well knew that it was not economy to buy cheap seeds. His valuable trade, when secured, was retained only by supplying seeds of the highest quality regardless of cost.

Since the close of the war the business of seed growing has rapidly increased. Notwithstanding some importers of seeds declared in 1867 that American seed growing was a myth, there were at that time more than 2,000 acres devoted to raising vegetable and flower seeds. In 1878, Mr. J. J. H. Gregory estimated the total area devoted to growing garden seeds at about 7,000 acres. Of these, 3,000 in the State of New York produced peas and beans; 250 acres, other vegetable seeds; and 50 acres, flower seeds. The remainder was distributed as follows: Michigan and northern Illinois, 1,600 acres; Pennsylvania and New Jersey, 1,000 acres; Massachusetts, Rhode Island, and Connecticut, 1,000 acres. The acreage for California is not given, but seed growing in that State was then practically confined to lettuce and onion seed, and the industry had been established for only about three years. Of the kinds of seeds which were sold in the United States, Mr. Gregory said:

> More or less of half the varieties are imported. Of mangel-wurzel, about all: ruta-baga, about nine-tenths; spinach, about nine-tenths; cauliflower, nearly all; lettuce, about half; carrots, about half; eggplant, about half; parsnip, about one-third; radish, about all. * * * It is the general belief of American seedsmen that foreign-grown radish seed is larger and better than home-grown. Parsley seed is largely imported. Brussels sprouts, broccoli, chicory, endive, kohlrabi, and Swiss chard are almost wholly imported, as is salsify, to a large extent. Of celery, the finest varieties are grown in this country in the vicinity of our large cities. Of cucumbers, but a few, and those of the fancy-frame sorts, are imported. Of peas, most of the hard sorts are home-grown, and probably rather more than half of what are called the softer or wrinkled varieties. The Dutch or rough-leaved turnip seeds are all home-grown. Of cabbage seed, but few varieties are imported, and these are confined almost wholly to a few early sorts. Onion seed is almost entirely an American crop.[1]

Besides the above, the seeds of beans, corn, squashes, tomatoes, and melons of all kinds were home-grown.

In 1878 seed growing was in its infancy in California. Seeds had been raised here and there since 1851, but the systematic development of the industry began in 1875, when R. W. Wilson planted 50 acres to beets, onions, lettuce, and carrots for seed purposes. From this beginning the business has grown to enormous proportions. A single firm of growers devotes annually some 2,000 acres to seed crops, and many other growers in California, Oregon, and Washington have built up a creditable business. "Onion and lettuce are staple seed

[1] Gregory, J. J. H.: Culture of Vegetable Seeds, in the Report of the Connecticut Board of Agriculture, 1878, p. 110.

crops, while carrot, celery, leek, endive, kale, kohl-rabi, parsnip, and parsley are all grown by California seed growers." In Washington cabbage and cauliflower seed is grown, and, although Puget Sound cauliflower seed does not yet enjoy the reputation of the Danish, further work may demonstrate that good seed can be produced in that region. Pl. XLVI shows a field of onions in California, and the method of thrashing the seed.

The census of 1890 showed that there were in the United States 596 seed farms, containing 169,850 acres, of which 96,567¼ were actually producing seed crops. Of these farms, 200 were established between 1880 and 1890, and it is safe to say that a large proportion of the 189 farms unaccounted for were also established during that decade. If this is true, about one-half of the seed farms existing in 1890 had originated since Mr. Gregory estimated, twelve years before, that in the United States 7,000 acres were devoted to garden seeds. But the census returns do not show the total number of acres actually devoted to growing seeds.

Seedsmen have for years grown most of their seeds on the contract system, contracting with farmers in different parts of the country to grow the seeds to which their soil and climate are best suited. Many of these men grow only one or two varieties, and in 1890 they made no returns to the Census Office. It is impossible to say how many acres are thus used for seed production, but many firms secure almost their entire supply in this way. In 1892 a grower stated that one firm had that year contracted for the product of 13,000 acres of vegetable seeds.

It is probable that Gregory's estimate in 1878 is too low; but even if it is doubled, it is still evident that during the ten years following 1880 seed growing increased out of all proportion to the increase in population. This overproduction was severely felt by growers everywhere. Before 1883 seed growing was very profitable, but since that date competition has been so keen and the demand for cheap seed so great that the profits have been much reduced. The financial panic of 1893 was felt by seedsmen as well as by those in other lines of business, but the trade is now rapidly recovering from that crisis.

The production of seed is, however, still increasing. Mr. C. L. Allen, a good authority, estimates that 100,000 acres are now annually devoted to peas and half as many to beans. In 1878 we imported half our wrinkled sorts; now we supply shortages abroad and import only in case of failure of the crop.

THE GROWING OF FLOWER SEEDS.

Flower seeds are extensively grown in California Edward J. Wickson in 1897 said:

> Various flowers have been grown for seed; in fact, a great assortment of varieties, and while nearly all kinds flourish, there is so much hand work and close application necessary that we have not been able to successfully compete with Europe

FIG. 1.—FIELD OF RED WETHERSFIELD ONIONS IN CALIFORNIA.

FIG. 2.—THRASHING ONION SEED IN CALIFORNIA.

FIG. 1.—FIELD OF TULIP-FLOWERED POPPIES IN CALIFORNIA.

FIG. 2.—FIELD OF PRIMA DONNA SWEET PEAS IN CALIFORNIA.

on most things. Sweet peas, nasturtiums, cosmos, verbenas, petunias, and asters are quite successfully grown, and the seed trade now looks to California for most of the sweet peas and a great many nasturtiums.

Southern California has several very prominent growers of fine double petunias and other plants. The rapid advance of the California sweet-pea seed in popularity is most marvelous. A beginning was made in this line in a moderate way about 1885, when there were not over a dozen varieties listed. At first about a quarter of an acre was grown; now one grower alone has grown from 150 to 200 acres of them each year for the past five years, and there are no less than 125 varieties in his complete list. This grower has introduced more than 20 varieties of great merit in the last three years, among them the famous race of "Cupids." So important a factor have the California sweet-pea growers become to the seed trade that some dealers come from the East annually to inspect the growing crops and to hunt for novelties in the sweet-pea line.[1]

Some flower-seed growers devote themselves largely to the production of new varieties. The seeds of these bring a better profit than those of the common sorts, which can be more cheaply grown in Europe.

In the Eastern United States flower seeds have been grown to some extent for at least fifty years. In 1849 James Vick began to grow flower seeds in New York State, and during the sixties flower seeds were grown in New Jersey, Pennsylvania, New York, and in New England. The amount raised was, however, never more than a small portion of that needed for the trade, and the greater part of the flower seeds sold was imported from Europe. This condition exists to-day. Flower seeds are grown in a number of places throughout the United States, but only a small portion of the trade is supplied with home-grown seed. Outside of California, limited amounts of flower seeds are grown, the principal kinds being asters, phlox, petunia, verbena, portulaca, zinnia, balsam, hollyhock, pansies, sweet peas, begonias, coleus, and some greenhouse plants. Pl. XLVII shows fields of poppies and sweet peas grown for seed in Santa Clara County, Cal.

SECTIONS AND CONDITIONS FOR PROFITABLE SEED GROWING.

The United States raises practically all its beans, and most of its cabbage, the best being grown on Long Island, while the cheaper trade is supplied from abroad, or from sections of this country where the seed can be grown cheaply. Carrot seed is largely grown, some of it in California, but the best is imported or grown in New England. The latter costs the most, though many dealers claim there is no difference in quality; but Mr. Allen thinks otherwise. He says: "Tests frequently made show conclusively that a larger yield of carrots can be obtained from Rhode Island and Connecticut grown seed than from the best imported." All corn, celery, lettuce, onion, melon, tomato, pepper, squash, and pumpkin seeds used in the United States are home-grown. All the cucumber seed except that of the French

[1] California Vegetables, 1897.

varieties is produced here, as is nearly all the eggplant and kale and a great deal of the beet seed. Sugar-beet seed is grown to a limited extent, and, with the further development of the manufacture of beet sugar, it will become an important industry. The best Brussels sprouts seed is grown here, most of the okra, and a great deal of the parsley, mustard, and spinach. Radish is grown to some extent, especially about Philadelphia, but many dealers do not consider American seed, at least of the small early sorts, equal to the best imported. Many other kinds are raised in a small way, but growers can not compete with the cheaper imported seed. There is, unfortunately, a great demand for cheap seeds, and low grades of many sorts can be imported more profitably than they can be produced by the American grower. Garden seeds are grown in most of the Northern and Western States and a few in the South. Many kinds are largely produced in certain favorable sections, as beans in New York State; cabbage on Long Island; peas in Canada, Michigan, and Wisconsin; vine seeds in Nebraska; and onion, lettuce, and sweet peas in California.

The value of a locality for seed growing depends upon favorable soil and climatic conditions and upon the supply of cheap labor at harvest time. Lack of labor often prevents the profitable culture of seed in places where conditions of soil and climate are favorable. The best onion seed is produced in Michigan and Connecticut, but for the general trade these seeds can not compete in price with the California product.

In general it is the practice of the seed trade to grow plants for seed purposes where the product attains the greatest degree of perfection. Seedsmen know where to look for their best seed as well as for the cheap grades, and when they have a discriminating trade they do not handle seed of questionable pedigree. Certain localities are specially adapted to certain varieties; onion seed grown in Southport, Conn., tends to produce round bulbs, while that grown at Wethersfield, in the same State, produces flat ones. A seedsman, besides being a thorough agriculturist, must know the character and wants of every variety.

Fifty years ago there were few seedsmen who understood varieties. To-day the seedsmen are variety experts, and note with accuracy differences so minute as to escape those not trained in their school. A shade of color in a sweet pea, the crumpling of a lettuce leaf, a slight difference in the shape of a bean or pea pod, all these are noted in the field and the plants saved or discarded as they conform to or depart from the type.

If anything is wanted, it is a greater fixedness of type. The tendency is toward the production of new varieties rather than the fixation and improvement of existing types. This results in unstable characters and in the speedy "running out" of varieties, whether by improvement or deterioration.

FIG. 1.—FIELD OF SILVERSKIN ONIONS ON BLOOMSDALE FARM, PHILADELPHIA, PA.

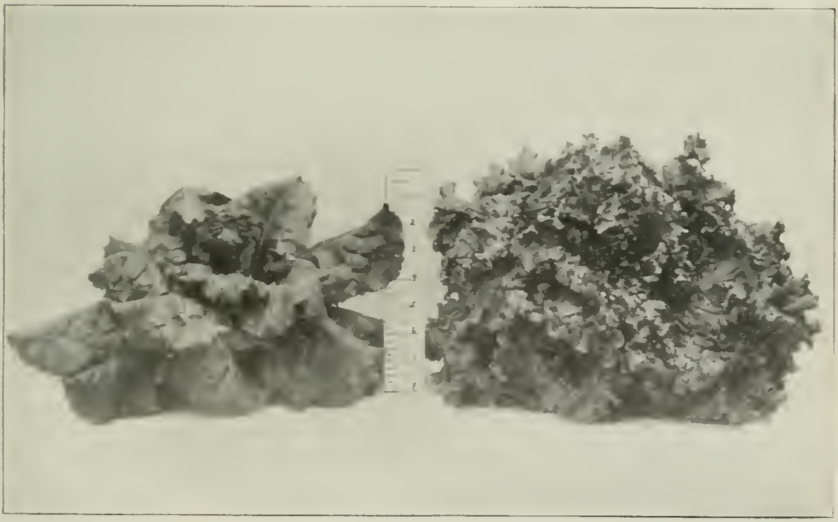

FIG. 2.—PRIZE HEAD LETTUCE, GROWN ON DEPARTMENT OF AGRICULTURE TRIAL GROUNDS: THE PLANT AT THE LEFT FROM CARELESSLY GROWN SEED, THE ONE AT THE RIGHT FROM PROPERLY GROWN SEED.

GROUPS OF SEED PLANTS.

To the seed grower plants fall into two groups—annuals and biennials; the former being such as produce a seed crop the same season that the seed is planted, while the biennials must be kept over winter and produce a crop about fifteen months after sowing. To the latter class belong cabbage, onion, turnip, carrot, parsnip, beet, winter radish, etc. In many respects these present greater difficulty to the grower, because the chances of failure are much increased. The crop may succumb the first season to any of the dangers always besetting plants; the plants or roots may spoil in the trenches or cellars during the winter, while if these dangers are safely passed it is still possible for the seed crop to be blighted at the eleventh hour. Onions may promise a bountiful crop till within a few days of harvest and then suddenly fail. Cabbage may be carried safely through the winter only to be finally ruined by an insect attack. Even in annuals the chance of loss is greater than any the market gardener encounters, the plants being longer on the ground and exposed to attack from more points than when the crop is marketed in the green state.

An additional source of loss is the destruction of plants not true to type. When seeds are carefully grown the fields are rogued so that only plants showing the characteristics of the variety are left; the remainder, no matter how good they may otherwise be, are discarded. This is a source of loss, and when seeds are grown cheaply it is avoided by permitting every plant to produce seed. The poorest plants, as they come nearest the wild type, will usually yield the most seed, but these seeds will in turn produce plants that will disappoint the most careless gardener. Plate XLVIII, fig. 2, shows at the left a lettuce plant raised from carelessly grown seed, and at the right the same variety, Prize Head, from properly grown seed. Such illustrations could be shown for nearly all vegetables, and the finer the strain the greater the deterioration when the seed is improperly grown.

All good seedsmen grow a special grade called "stock seed." This is kept solely for their own use and is sent out to their different growers to plant for the regular crop. This "stock seed" is grown and saved with unusual care. Every precaution is taken to keep the variety pure, and the selections are made with extreme rigidity. Only the best plants are used and the destruction of so large a portion of the crop makes the stock seed too expensive for general sale. To absolutely prevent mixture the plants for stock seed are often grown in the middle of a large field of the same variety intended for crop purposes. This prevents the bees from bringing foreign pollen to the selected plants, and insures purity of stock. The mixing of varieties is something the seed grower has always to guard against. To prevent this only one variety is commonly grown on a farm, and care is taken to see that a near neighbor is not growing another variety of the same species. When only small quantities of seed are raised, a block of the variety is frequently planted in the midst of a cornfield.

HARVESTING.

Harvesting operations must be carried on with great skill and care. Seed crops are usually cut when about two-thirds of the seed is ripe. If left longer there is great loss from the rattling out of the ripest seed. The seed stalks are cut with a sickle and laid on large canvas sheets. The four corners of these are then drawn together and the bundles carted to the barns. Here the seed stalks are laid on scaffolds to dry, after which the seed is thrashed out. The flail is the implement still most largely used in this work, though there are various special machines in use. On the large farms of one California firm all seeds except onion are thrashed with a flail. Seeds surrounded with pulpy flesh need special treatment. Tomatoes, cucumbers, and melons are first crushed in a press, or the seeds and pulp removed with a scraper. The entire mass, consisting of seeds and pulp, is then allowed to ferment until the pulp is rotten. The mass is then washed, the pulp rises, and is thrown out, while the seeds sink and are drawn off and the light seeds removed with a fan. The casks of fermenting pulp must be carefully watched, for if the process goes too far serious injury to the seed may result.

AGRICULTURAL SEEDS.

Many years before the growing of garden seeds had become important the farmers of this country had ceased to depend upon Europe for their supply of farm seeds. Some of the staples even became articles of export at an early day, and enough was grown of nearly all sorts to meet the home demand. As agriculture advanced the use of clover and grasses became more common, and the home supply of seed from being unequal to the home demand, not only met the increase, but began to be exported to England, and in 1841 a few bushels of clover seed were sent from Cleveland, Ohio, to Canada.

For many years the United States has produced enormous quantities of clover and grass seeds, and exports have in some years amounted to millions of dollars. The imports of grass seeds are confined to the so-called fancy grasses, which can be more cheaply gathered in Europe than here, and to cheap clover and grass-seed screenings. The latter are imported to mix with higher grades, and thus lower the cost to the seller. During the last few years a great deal of awnless brome-grass seed has also been imported, but this is now grown in the Northwest, and before long we shall be independent of the foreign supply. There is scarcely a region in the United States in which some of our agricultural seeds can not be grown, but their profitable production is generally confined to more or less well-defined localities, depending upon favorable climatic and soil conditions.

Red clover is grown throughout the Northern and Central States, but mainly in the country tributary to Toledo, Ohio, which is the great clover-seed market. The culture of the seed is, however, extending westward, and the time may be not far distant when Chicago will take first rank as a clover-seed center. Timothy seed can be grown wherever red clover flourishes, but its principal area lies farther west, some counties in Iowa being the largest timothy-producing sections in the world. Orchard grass, redtop, Kentucky blue grass, meadow fescue, and the millets are grown in several of the Middle and Western States, but the areas of production frequently shift. Hundreds of tons of alfalfa seed are raised in Utah, and the teosinte grown in Florida more than supplies the home demand. With few exceptions these seeds are raised by the general farmer as a part of his regular crop. Their production on regular seed farms has been attempted, but did not prove profitable, the prices that were satisfactory when the seed was raised as a secondary crop not proving sufficient to meet the expenses of special production.

Unfortunately, clover and the standard grass seeds have become objects of speculation on the produce exchanges of the great cities. This causes fluctuations in price entirely independent of the legitimate supply and demand and frequently interferes with sales abroad, buyers not being willing to invest while the market remains unsteady.

IMPROVEMENT IN HARVESTING AND CLEANING GRASS AND CLOVER SEEDS.

In harvesting and cleaning grass and clover seeds there has been great improvement. Not only have the harvester and the horserake taken the place of hand labor, but the machinery for cleaning the seed has attained a much greater degree of perfection than was thought possible even twenty-five years ago. The evolution of the clover huller has been gradual, and has progressed step by step toward its present condition. In the early years of the century the seed was separated from the heads with a flail or by treading the straw with horses. Later, milling machines were invented or sometimes regular flour mills were slightly modified and used for hulling the clover seed. In the American Farmer of 1821 Caleb Kirk described a mill for cleaning clover seed. This was made somewhat like a flour mill, but the stones were not allowed to touch. The miller received a toll of one-tenth for his work, and the mills could turn out under the most favorable conditions about 10 or 12 bushels of seed in a day. Several of these mills were established about the country, but many farmers still preferred to tread out the seed with horses, partly to save the toll and partly because the milled seed, not being so clean, brought a slightly lower price.

Another machine, invented by John Bolton, of Warren, Herkimer County, N. Y., would clean 1 bushel per hour when run by water power. It could be built for $30 or $40. Some time before 1831

Thomas D. Burrall, of Geneva, N. Y., invented a machine that was a long step toward the present huller. It was constructed with a cylinder armed with thin triangular iron teeth, revolving over a bed of perforated sheet tin. Below the cylinder was a fan, which blew out the chaff and light seed. The clover heads were first freed from the straw and were then fed on to the cylinder. This machine when run by water power cleaned from 2 to 3 bushels of seed per hour. A full description was published in the American Farmer of 1831.

Other machines were also in use up to 1855, but they did not have huller and fan combined. In 1855 a combined clover huller was exhibited at the New York State fair in Buffalo. The present combined clover thrasher, huller, and cleaner is too well known to need any description. There has been a steady advance toward perfection, until to-day the clover is put in at one end of the machine and clean seed runs out at the other. There are several makes differing more in detail than in principle, and all aiming at the same result—to clean the most seed in the shortest time and at the least expense.

The mills in use during the twenties hulled from 10 to 12 bushels a day under the most favorable conditions, and the seed had to be recleaned before marketing. To-day a good machine will clean as many bushels in an hour.

There has been even a greater change in the methods of cleaning Kentucky blue-grass seed than in the case of clover. In 1814 John Nicolson, in the Farmers' Assistant, said of this grass: "It yields plenty of seed, but this is difficult to sow on account of their filaments causing them to adhere to each other. To remedy this, it is recommended to put them in newly slacked lime, to separate them, and then to be rubbed in dry sand." In antebellum days slaves were employed to rub the grass between their hands, which were protected with old boot legs, and as late as twenty-five years ago the seed was rubbed by hand through wire cloth. It was possible by this means for one man to clean from 15 to 20 bushels per day. Now, with the improved patented machinery, one man can clean 100 bushels a day, and the machinery when run by a 60-horse power engine has a capacity of 600 bushels per day.

THE PROGRESS IN VARIETIES.

Vegetable seeds.

Anyone studying the modern seed catalogue with its bewildering number of varieties may almost wish for the simplicity of the early days of this century, when a dozen varieties of any one kind was a long list. Davidson in 1768 offered 57 varieties of vegetable and herb seeds. Thorburn in 1805 had a list of 70 varieties, all vegetable seeds, and among these were neither squash, tomatoes, nor sweet corn. As the years went by the number of varieties increased, at first slowly, since only those markedly distinct were noted, but with the great development of the seed trade after 1860 the number of varieties catalogued increased with almost incredible rapidity. Every year witnesses the advent of novelties, real and imaginary, many of them without permanent value, but a few are genuine additions to our horticulture. Professor Bailey said in 1892:

This increase is in part simply an accumulation of the varieties of many years, so that our manuals are apt to contain descriptions of more varieties than are actually cultivated at the time. But much of this increase is a natural multiplication of varieties, that is, there are more varieties of nearly all plants in cultivation now than at any previous time. M'Mahon mentioned 6 beets as grown at his time; in 1889 there were 42 kinds. Then there were 14 cabbages, now there are over 100. Then there were 16 lettuces against about 120 now.[1]

It may be added that last year more than 300 varieties of lettuce were catalogued, of which 292 were grown on the trial grounds of the Department of Agriculture and 82 of them were considered distinct.

Twenty years ago the large and small lima beans were the only representatives of that class; to-day there are several better pole limas, besides the whole race of dwarf limas that were entirely unknown to our grandmothers. These acquisitions to the vegetable garden all arose as chance sports, and some of them were cultivated for several years before they were given to the trade. The story of the production of these purely American types is thus told by Professor Bailey:

They appeared in the same way that nearly all new varieties of plants originate; they were found growing amongst plants of common and well-known varieties. A single plant, a "sport," was first observed in some cases and in others several original plants were discovered. The Kumerle, or Thorburn, Dwarf Lima originated from occasional dwarf forms of the Challenger Pole Lima, which J. W. Kumerle, of Newark, N. J., found growing in his field. The Henderson, as we have seen, was a chance dwarf picked up in Virginia. The Burpee came from a single plant of the large white lima. Mr. Palmer, with whom it originated, had his entire crop of limas destroyed by cutworms in 1883. He went over his field to remove the poles before fitting the land for other uses, but he found one little plant, about 10 inches high, which had been cut off an inch above the ground, but which had rerooted. It bore three pods, each containing one seed. These three seeds were planted in 1884, and two of the plants were dwarf, like the parent. By discarding all plants which had a tendency to climb in succeeding crops the Burpee Bush Lima, as we now have it, was developed.[2]

Besides the above, Wood's Prolific Bush Lima and Burpee's bush form of the willow-leaved lima have been more recently introduced.

Of bush beans, there were half a score in 1834 and about the same number in 1860. There are now 370 varieties catalogued, only a few of which were known thirty years ago, and of these probably one-fourth are distinct. The best varieties of cauliflower grown in the United States to-day have been introduced by American seedsmen. Sweet corn was not catalogued in the early days of the century, and

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[1] Bailey, L. H.: Survival of the Unlike, p. 203.

[2] Bailey, L. H.: The Dwarf Lima Bean, in Bulletin No. 87, Cornell experiment station, p. 86.

there were only 4 varieties in 1869; now there are more than four times as many. Twenty years ago there were no distinctively forcing varieties of lettuce in general use, while to-day we have several that can not be fairly tested out of doors. Out of the 40 varieties of peas known in 1879, only 6 were of American origin. The next year the American Wonder appeared, and since then American seedsmen have introduced many of the best varieties. Our valuable squashes are all of American origin, and of the long list of large tomatoes there is not one that was known thirty years ago.

It is interesting to note the history of the tomato, its gradual rise in popularity, and the rapidity with which new varieties appeared when once its position was assured. Originally an American contribution to horticulture, it was first used as food by the Latin races of Europe. Philip Miller in his Gardener's Dictionary, 1731, says: "The Italians and Spaniards eat these Apples (Love Apples) as we do Cucumbers—with Pepper, Oil, and Salt—and Some eat them stewed in Sauces, etc., but, considering their great moisture and Coldness, the Nourishment they afford must be bad." In New Orleans they were used in catsup as early as 1779, but in the English colonies tomatoes were planted only as ornaments, under the name of "Love apples." In 1836, however, they had begun to be popular as food. Thomas Bridgman, in the Kitchen Gardener's Instructor, tells us that at this time the tomato was used in sauces, as dessert, as a substitute for peaches, and that it also made excellent pies and tarts. There were only two varieties, however, the large red and the cherry. Their use gradually increased, and in 1841 they had "become almost an indispensable dish through the summer months on every table." In 1847 there were six or seven varieties, but there was not much difference among them. By 1860 hundreds of acres were planted with this fruit in the vicinity of Philadelphia alone, and some efforts had been made to secure improved sorts, a smooth kind being especially desired. Shortly before 1860 a large, smooth red variety became popular. At this time there were, besides the yellow and the cherry kinds, but four varieties, and only two of these were widely known.

In 1865 the tomato was a universal favorite. It had become a commercial staple, and 1,000 acres are said to have been devoted to its cultivation in the neighborhood of Philadelphia. During that year the Tilden appeared, and at once took first rank. In the next five years the Maupay, Foard, Eureka, Cook's Favorite, Boston Market, Dixey, Crimson Cluster, and General Grant were introduced, the General Grant being the best of the number and a really good tomato. In these five years more varieties were brought forward than had been known during the preceding fifty. The canning industry consumed thousands of bushels, and the interest in the tomato was widespread. For many years lovers of the tomato had been selecting seed in order to improve the existing sorts, and the new varieties were the outcome of this work. The best of these varieties was the Trophy, introduced in 1870 by George Waring, farmer and sanitary engineer. "The time was ripe for a tomato of a new type, one which should be large and early, and, above all, with a regular, apple-like form, or 'smooth.' The Trophy came at the right time, and it was the right thing. Its success was unbounded. It was almost the making of modern tomato culture. It marks an epoch in tomato growing in this country which has yet scarcely been reached in any other country."[1] The Trophy was the result of twenty-three years' careful selection, and was a great success. In spite of the high price ($5 for twenty seeds) it was soon widely distributed, and if sometimes it received a word of condemnation, its increase in popularity was a guaranty of its value. New varieties, some of them selections from the Trophy, now appeared in rapid succession, and were eagerly taken up, introduced, and advertised by the seedsmen. From 6 varieties in 1860 the number increased to 30 in 1880, and in 1899 American seedsmen catalogued 242 varieties of tomato. Of these, possibly 50 may be distinct and better than the Trophy.

Flowers.

The development in the varieties of flowers grown from seed, if not so conspicuous, has been not less remarkable. Indeed, it may be said that in the entire history of the seed trade there has been nothing to equal the phenomenal improvement in the sweet pea. The old Painted Lady was a favorite in our grandmothers' gardens, and until the beginning of the eighties was easily first among the half dozen known varieties. In 1882 one of the first retail seed firms to take up the sweet pea catalogued eight varieties; last year its list numbered 258. Although the modern sweet pea owes more to Mr. Eckford, of England, than to anyone else, there is probably no country where it has attained greater popularity than in America. American seedsmen have also introduced many valuable varieties, beginning in 1891 with the introduction of the Blanche Ferry, a descendant of the Painted Lady. The Blanche Ferry was found in a garden in northern New York, where it made a rapid growth, took on a dwarf habit and "became a 'cropper,' that is, all the flowers, which in other climates would have a much longer period in which to develop, here appeared nearly all at the same time if not cut."[2] Since then 35 varieties, mostly of the grandiflora class, have been introduced by our seedsmen. Two distinct types—the dwarf, or Cupid, and the Bush sweet pea—have also been developed on American soil.

The White Cupid was first discovered as a chance sport on the seed farms of C. C. Morse & Co., in California, in 1894. Since then they "have developed nearly 100 different tints and colors" in Cupids

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[1] Bailey, L. H.: Survival of the Unlike, p. 480.

[2] Allen, C. L.: American Agriculturist, September 7, 1895.

alone. Most of these have not yet been introduced, but every year adds to the number of established varieties. Burpee's Bush sweet pea, also a chance seedling, was first introduced in a limited way in 1899, and already a new variety, the New Monarch Bush, has appeared in the list for 1900. There has been a great improvement in the varieties of flowers all along the line, and although most of the new varie-

FIG. 25.—Sweet peas, old and new: *a*, from Vick's Magazine, 1886: *b*, the Aurora sweet pea.

ties are of European origin, we owe not a few of them to our own growers. (For old and new sweet peas, see fig. 25.)

Mr. Darlington writes of the asters as follows:

Asters, twenty years ago, were nearly all of a similar type of flowers, and the range of coloring was much less varied than at present. Now we have the beautiful flowers of the late branching varieties, which rival the chrysanthemums as a fine florist's flower. This year a strain of tall branching comets is introduced, which will be of great value as cut flowers during the early fall, combining size and graceful feathery form with stems of good length. In the late branching varieties we have a distinct type of purely American origin; these now exist in pure white, lavender, flesh pink, and deep pink, with ample promise of other shades to come.[1]

SEED TESTING.

Since the days of tradition there have been various and sundry ways of finding out the quality of seeds. They have been floated or have

[1] Darlington, E.: Growth and Development of the Business in Flower Seeds During the Past Twenty Years, in Seventeenth Annual Report American Seed Trade Association, 1899, p. 49.

been heated until they popped; they have been broken and the fracture noted; they have been cut and judged by the appearance of the inside. Besides these superficial and inaccurate methods, germination tests have been resorted to more or less commonly for over a hundred years.

Our own agricultural literature is full of advice about this matter, and the older seedsmen not only urged customers to test their seeds, but set them the example by sprouting a few in pots of soil which they kept in their seed stores. Unfortunately, this good advice was not generally followed; seeds were planted, and if disappointment came the seedsman was blamed, often unjustly. In 1827 Grant Thorburn wrote, "besides good seeds, good gardeners are necessary in making a garden flourish." While many of the failures with seeds have been caused by improper planting, due either to ignorance or carelessness, farmers and gardeners have often been deceived by unscrupulous dealers. They have bought seeds in good faith and have found them worthless; they have thought they were sowing clover, but have reaped thistles.

SEED TESTING WORK IN EUROPE.

Fortunately for American agriculture, the poor-seed evil never attained the proportions here that it did in Europe. There matters became so bad that factories were openly established to crush and color quartz to mix with clover. In England a large capital was invested in the business of killing weed seeds to adulterate valuable kinds, but the practice was finally prohibited by Parliament. In 1869 Dr. F. Nobbe began testing seeds at his laboratory in Tharand, Saxony; this was the beginning of the extensive seed-control work in European countries. Naturally, Dr. Nobbe met with much opposition at first from both dealers and consumers, but he made out his case so clearly that the German farmers were convinced of the value of seed testing. To-day there are many stations in Europe, and some of them have control contracts with the leading seed merchants. The work is appreciated, and the workers take an honored place among the practical and scientific men of the day.

SEED TESTING IN THE UNITED STATES.

In the United States reputable seedsmen have tested their seeds for germination, probably since the first seed firm was started. The State experiment stations have for a long time done something in practical seed testing. In Connecticut Prof. E. H. Jenkins began testing seeds in 1877, and this station has done some of the best work in this country. In the same year Dr. Beal, of Michigan, tested some seeds, and two years later Professor Ledoux began seed testing at the North Carolina station. At the Geneva station Professor Goff first used what is now known as the "Geneva tester." Among other stations that have contributed to the work are Arkansas, Cornell, N. Y., Delaware, Illinois, Indiana, Iowa, Maine, Massachusetts, Minnesota, North Dakota, New Mexico, Pennsylvania, Rhode Island, South Carolina, South Dakota, Vermont, and Wisconsin. In 1893 the Botanist of the Department of Agriculture recommended that seed testing be undertaken systematically and scientifically, and in 1894 Gilbert H. Hicks was appointed and placed in charge of the laboratory. Mr. Hicks's untimely death in December, 1898, deprived American seed testing of one of its ablest and most devoted exponents.

During the last few years there has been an increase of interest in seed testing; several stations have published the results of tests and others are preparing to begin this work.

The Association of Agricultural Colleges and Experiment Stations, at its meeting in Washington City in 1897, appointed a committee consisting of Professors Jenkins, Card, Lazenby, McCarthy, and Mr. Hicks to draw up rules and regulations for seed testing. The report of this committee was adopted, and the stations are now working under uniform rules, several stations having procured the official apparatus.

Methods of testing by seedsmen.

Most reputable seedsmen make germination tests, and by some these tests are conducted with great care. There is no uniform method of testing, however. In 1887 the American Seed Trade Association appointed a committee to adopt some uniform system, but the writer has been unable to learn that a report was ever made.

To the seed tester all seeds belong to one of two classes—those of which the botanical purity can be determined from the seed and those of whose purity one can judge only by the plants they produce. Roughly speaking, the first class includes most agricultural seeds, especially those of grasses and forage plants; while to the second class belong the garden seeds, more particularly those of vegetables and flowers, the varieties of which can not be distinguished by the seed. The seeds of the first class are much more easily tested than those of the second, and their value for seed can be accurately determined long before planting. Not so with garden seeds. The thing of most importance with them is that they be true to name and of good stock. It is, of course, essential that the seeds germinate, but a gardener would rather have cabbage seed of low vitality and of good stock than of poor stock and good vitality. In the first case he may not get more than 25 per cent of plants, but almost every one of these will make a head, while of the other seed he may get 90 per cent of plants and but few marketable heads. So important is this matter of genuineness that most good seedsmen conduct trial grounds where the different stocks are grown and observed.

The trial ground is the seedsman's testing station, and its importance can not be overestimated. Here he plants not only samples from his

FIG. 1.—PORTION OF THE TRIAL GROUNDS OF FORDHOOK FARM, PHILADELPHIA, PA.

FIG. 2.—PART OF THE ASTER TRIALS ON FORDHOOK FARM, PHILADELPHIA, PA.

FIG. 1.—PORTION OF TRIAL GROUNDS OF THE DEPARTMENT OF AGRICULTURE, SHOWING LETTUCE TRIALS IN FOREGROUND.

FIG. 2.—PORTION OF THE PEA TRIALS ON THE GROUNDS OF THE DEPARTMENT OF AGRICULTURE.

own stocks, but also from those of his competitors. As the season advances he reads the field like an open book. He may be surprised to find that one stock has proved untrue and must be discarded next year. Of course, the knowledge comes too late to prevent trouble that year, but the same mistake can be avoided in the future. Without the trial grounds a seedsman might sell poor stocks for several years without learning, except from the complaints of his customers, that they were unfit to use.

The tests on a well-regulated trial ground are made in good but not highly enriched loam. The seeds are planted in rows from 5 to 60 feet long, according to the kind and variety, and a white label bearing a number is placed at the head of the row. This number refers to a record book in which is kept a careful entry of everything relating to that seed, where and by whom grown, in what year, the date planted, when the sprouts first appeared, and the vigor of germination. As the plants grow they are carefully observed, notes being made of growth and character. These notes are continued throughout the season, and from this record the experts decide on the value of the stock. A vast amount of detail work is necessary in caring for these trial grounds, but they are essential to a thorough knowledge of varieties. Pl. XLIX shows portions of the trial grounds on Fordhook farms near Philadelphia, Pa.

So far as the writer knows, but one commercial seed-testing laboratory exists in the United States. This was established by Mr. Frank Sempers at Blythedale, Md., in 1897, and is known as the Blythedale Seed Laboratory. The work is confined to germination tests, and the laboratory represents the trade only. The number of tests made has increased rapidly since its establishment, and at present it has a capacity of 36,000 continuous tests.

Seed testing by the Department of Agriculture.

The Department of Agriculture has conducted a small trial ground for the last three years in connection with the seed laboratory. Here studies of varieties are made, all the obtainable varieties of one kind being grown for one or more seasons and careful notes and photographs taken. When completed these records make up accurate descriptions of all the standard sorts, with the synonomy. Experiments in growing special crops are carried on, and many new or little-known economic plants are cultivated. Undetermined weed seeds found in imported grasses and forage plants are also planted and the plants grown to maturity. Many of these prove to be weeds unknown in the United States, and the Department can thus to some extent keep informed of the character of the weeds now being introduced into this country. Samples are also planted of all seeds sent out for Congressional distribution. Portions of the trial grounds of the Department of Agriculture at Kensington, Md., are shown in Pl. L.

For the testing of grass, clover, and other forage-plant seeds the trial grounds are not as much used as the laboratory and greenhouse. In both of these respects the Department of Agriculture is well provided. The laboratory is equipped with balances, lenses, reading glasses, a seed collection, and all the other apparatus necessary for making purity tests. There are also germinating chambers, with all the necessary accessories, and abundant greenhouse facilities.

The method of making tests is essentially similar to that in use in all seed-testing stations. When a purity test is to be made, the sample is first poured into a bowl and thoroughly mixed. A small sample, varying in weight from 1 to 25 grams, according to the size of the seed, is then weighed and spread upon a sheet of white paper. Here it is examined with a hand glass, if necessary, and all foreign matter removed. The inert matter, as sticks, stones, dirt, broken seeds, and chaff, is placed on one side and weighed; also, all seeds not of the kind under examination are removed and weighed. The percentage f each kind of impurity is then determined and recorded. The weed seeds are identified, and their names are recorded with the number found in the weighed sample.

Sieves, mirror boxes, and other special pieces of apparatus are constantly used in the course of the test, which is completed as expeditiously as is consistent with absolute accuracy. The germination tests are made either in the chamber or greenhouse, or both, as is best suited to the particular variety. The chambers used are of the kind approved by the Association of Agricultural Colleges and Experiment Stations. Blue blotters and canton-flannel folds are used to hold the seeds, and the moisture and temperature are regulated according to the needs of the variety. Many grass seeds are tested in sand in the greenhouse, experience showing that such a test is most reliable. Special methods have also been found advantageous for some seeds. These methods have already been described in the publications of the Department, and need not be dwelt upon here. Nor is testing the only work undertaken by the laboratory. Studies are being constantly made with a view to devising better apparatus, such as will aid in facilitating tests, and experiments are conducted in order to clear up difficult points in the germination or preservation of seeds.

INDICATIONS OF GROWING INTEREST IN SEED TESTING.

Seed testing is still but little developed in America, and there is a wide field for faithful and persistent effort. To a certain extent, the work is hampered by the apathy of the buyers—more by this than by the hostility of the sellers of seeds; but there are indications of a growing interest in better seeds and a clearer understanding of the value of having seeds tested before planting. This interest and this understanding it is the duty of the station to foster and increase, and its work will grow with the growth of a sentiment in favor of high grade, guaranteed, and tested seeds.

PROGRESS OF COMMERCIAL GROWING OF PLANTS UNDER GLASS.

By B. T. Galloway,

Chief of Division of Vegetable Physiology and Pathology.

EARLY HISTORY.

The special branch of horticulture which has for its object the production of plants under more or less artificial conditions of light, heat, and moisture has come to be generally known as the growing of plants under glass. In this country the business includes all plants grown in specially constructed glasshouses and in hotbeds and cold frames. The growing of plants under bell jars, as practiced in Europe, is not followed here.

Probably nowhere in the world has the growing of plants in greenhouses attained such importance as in the United States. Other countries may have more imposing structures and larger individual areas of glass, but, taking the business as a whole, it may be fairly claimed that in up-to-date methods in almost everything pertaining to this special field of horticulture this country leads.

It is difficult to say when and where the practice of forcing plants originated, but it is certain that the Romans were able to supply the tables of the wealthy with choice vegetables at almost any time of the year. The gardeners of the Roman Emperor Tiberius were familiar with this kind of work, and forced cucumbers and other vegetables during the winter and early spring months. The crops were forced in pits heated with manure and protected from cold by thin sheets of mica and in various other ways. The manure was put into the pits very much as is done in making hotbeds at the present time. Baskets containing fermenting manure were also used in which to force plants. These baskets were moved about to meet the requirements of the weather, and by being properly protected during cold days and at night vegetables were brought to perfection in them. It is even claimed that hot water was used by the Romans for the purpose of heating the pits, and from what we know of practices followed by them this does not seem unlikely.

With the decline of the Roman Empire and the gradual dissipation of wealth and culture which followed, the higher branches of horticulture were neglected and soon passed out of memory. From this period down to the sixteenth century there are few records which indicate any advanced ideas on the subject. The work that was undertaken was confined for the most part to the gardens of rulers and others who had means to carry out elaborate plans in landscape gardening. It is doubtful, however, if anything of consequence was done at this time in the way of forcing plants, as such a practice would require a knowledge which the gardeners of the time did not possess.

Passing over this long period and coming down to modern times, we find that even at the beginning of the present century but little was being done in this country in the special field of horticulture treated of in this paper. It must be remembered, however, that in the year 1800 the United States was young and every available man was needed in the work of conquering the wilderness and overcoming the great natural obstacles that are always found in a new country.

A study of history shows that countries, like individuals, are busied

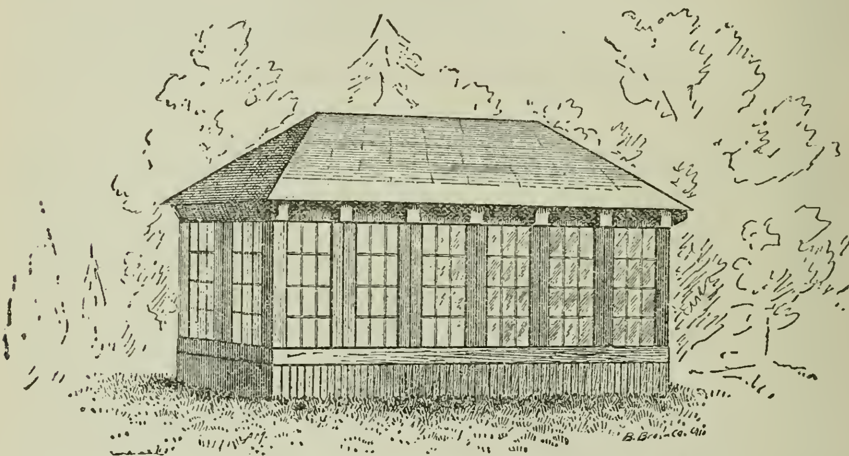

FIG. 26.—First greenhouse in America, constructed in 1764 (American Florist).

first with a mere struggle for existence, and that so long as it is necessary to put forth every effort to live little attention is given to luxuries like flowers. Here and there men are led aside by pure love for this kind of work, but they resemble the pioneers in literature and art, in whom sheer devotion overcomes all obstacles.

With the exception of some establishments of a semiprivate nature, there was little, so far as can be determined from the records, in the way of commercial plant growing under glass up to 1810. Greenhouses were scarce, and those in existence were not designed for much in the way of commercial work. The greenhouse generally believed to be the first erected in America (fig. 26) was built in New York in the year 1764. During the succeeding twenty-five or thirty years comparatively little was done in greenhouse construction. The house referred to was for many years a landmark, but was finally torn down to give place to advancing business. It is interesting to notice the construction of this greenhouse, as showing from what a small beginning the immense business of the present time sprang.

The early structures were crude affairs (fig. 27) when looked at from the present view point. The roofs were for the most part of wood, glass being used only for the sides and ends. In one of the books on gardening of that period the greenhouse was described as being built preferably 16 feet wide and of any length desired. The front, it was said, should be of sash 12 to 15 feet high, and should be provided with outside wooden shutters so as to protect the glass in extreme cold weather. The roof, the book goes on to state, should be of shingles, and the back wall of brick, 6 to 9 feet high, with flues through it, and there should be a shed to shelter this wall and a furnace under the shed connecting with the flues in the wall for the purpose of heating the house in cold weather. In many instances these houses were constructed in such a way that the gardener lived in the second story, the lower part being given up to the growing of plants.

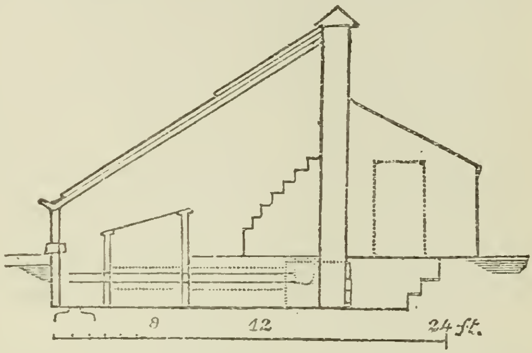

FIG. 27.—Plan of early form of greenhouse, 1836 (Hovey's Magazine).

BEGINNING OF AN ERA OF PROGRESS.

It was not until about 1825 that real progress in growing plants under glass began. The reason for this may be assigned to a number of causes. The country had been through several wars and had now settled down to growth and prosperity. The Eastern States were rapidly increasing in population and wealth, this being especially the case in the vicinity of the cities of Boston, New York, and Philadelphia. It was natural, therefore, that with the accumulation of wealth in such places and the relaxing of the strain necessary in the struggle for existence, money should be turned into other channels than those of necessity.

In these early days Philadelphia took the lead as a market for plants, flowers, and vegetables. The wealth and culture of the times were centered here, and besides much had been accomplished in the way of creating a taste for such things by the active work of a few individuals in whom there was an inherent love for all that is beautiful in the plant world. It was to Philadelphia, therefore, that gardeners from the Old World were attracted, and it was not long before several societies were organized that had a marked influence in developing an interest in the business. Philadelphia, furthermore, possessed advantages in other ways over her more northern sister cities. The mild winters there made it possible to carry on many lines of work with greater ease than in New York or Boston. The latter city, however, was not content to remain long in the second place in such work, and for a time in these early days her gardens and greenhouses were second to none in the country. New York was behind in this respect, for the time of her people at this period was so fully occupied with commercial interests that little attention could be given to anything else. Baltimore, Washington, Charleston, and other cities soon became centers of wealth and culture, and thus the demand for both plants and flowers rapidly increased. Horticultural societies were formed in all the cities named and did a great deal toward awakening an interest in their fields of labor. The work at this time, however, was of the most general nature. In fact, all commercial establishments were compelled to grow trees, shrubs, and many other things which would now be looked upon as foreign to a gardener's establishment.

With the increasing demand for plants, flowers, and vegetables at this time (1830) came the necessity for better methods of growing them; hence, there was a marked improvement in greenhouse construction, especially in heating. The method of heating by means of hot-air flues, then generally prevalent, practically confined the work within certain bounds, but with the advent of hot-water heating the possibilities of the gardener were greatly increased, as he was thereby enabled to keep his plants in better health and could therefore greatly increase their productiveness. He was furthermore enabled to heat his house with far less attention to this particular item than ever before, and this left him freer to pay more attention to other phases of the work.

Although water had been used in heating buildings for many years prior to this time, its application to greenhouses was limited. The systems first in use here were borrowed mainly from England, and were expensive, owing to the fact that both the boilers and the pipes were made of copper. Americans, however, soon commenced to improve the systems and to put forth efforts which would bring them into greater harmony with the conditions existing in this country. One of the pioneers in this work was Mr. Thomas Hogg, of New York, who devised a system which represents the important principles in use to-day (fig. 28). Mr. Hogg made the heater in such a way that the fire was completely surrounded by water, the latter circulating through the boiler and thence through cast-iron pipes to an expansion tank, and thence back to the boiler. The part of the boiler containing the water was a wooden vessel, and inside of this was placed an iron shell containing a grate, in which the fire was made. Fuel was added through a hole in the top of this iron shell, the shell projecting above the water in the vessel. Soon other heaters, made on the same plan, but more perfect, were devised, most of them consisting of tin or copper boilers made in the shape of a double cone. The inside cone was used as a furnace, while the space between the cones was filled with water. Openings for outflow and inflow were arranged at the top and bottom, in much the same way as is done at the present time in some of the conical boilers.

The introduction of hot water marked an epoch in greenhouse work, and for the next ten or fifteen years progress was rapid. In 1835 there were extensive greenhouses in the vicinity of New York, Boston, Philadelphia, and other cities, the houses of one establishment on Long Island aggregating over 400 feet in length. According to one of the prominent writers of the period, there were similar establishments which devoted much of their space to the growing of flowers for winter bouquets, camellias, roses, peonies, etc., being generally used for this purpose. Considerable attention was also given to the forcing of vegetables in hotbeds, especially lettuce. In this period the latter crop was quoted during midwinter at from 6 to 10 cents per head, practically the same price as is received for it at the present time. Vegetables were grown exclusively in hotbeds at that time, lettuce, radishes, and cucumbers being the principal crops.

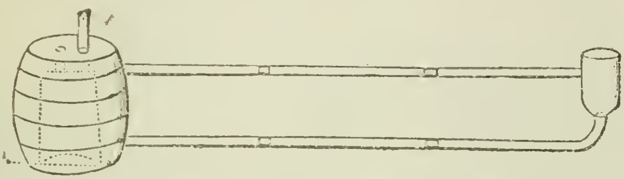

FIG. 28.—Hogg's hot-water heating apparatus, 1832 (Hogg's Magazine).

It is unnecessary to dwell at length on the changes wrought during the period between 1840 and 1850. Suffice it to say that with the rapid growth of the country the industry developed in a most remarkable way. Many improvements were introduced into greenhouse construction, and these, with the introduction of new plants and the improvement of others by selection and breeding, broadened the scope of the work. It was at this time that roses began to attract general attention, and a great deal of space was devoted to their culture, especially to the hybrid perpetuals and teas. Important advances were made in the introduction of fuchsias, gladioluses, and many other plants of this kind. Japan lilies also began to attract attention, and as soon as it was found that they were in a measure hardy the demand for them rapidly increased.

An important change in the construction of greenhouses was the abolishment of the sash roof and the substitution of the fixed roof. The great majority of greenhouses were of sash, and a fixed roof offered opportunities for diminishing the cost of construction and making marked improvements in ventilation and light, as well as in other particulars. Bedding the glass in putty instead of placing the putty on the outside was another innovation introduced quite generally about this time. This simple change added years to the life of the house and made it much better for the work in every way.

It is difficult to say when and where these improved methods of construction were first introduced. Fixed roofs were used in England as early as 1818, and there are descriptions of curvilinear grape houses erected on this plan during the same year. The method of bedding glass in putty was certainly in use in England as early as 1838, for it was thus described in 1843: "A good bed of prepared putty is laid on the rabbet and the glass is placed upon it, * * * after which a little white paint is run, with a small brush, almost a quarter of an inch wide, down each side of the square of glass."[1] The same writer says that he constructed a house on this plan in 1838. The method is described in this country in the Magazine of Horticulture for 1845. The gardener who erected the houses for the English writer says, in describing them, that the glass was not only bedded in putty, but was butted, the edges being dipped in copal varnish to prevent leaks between the panes.

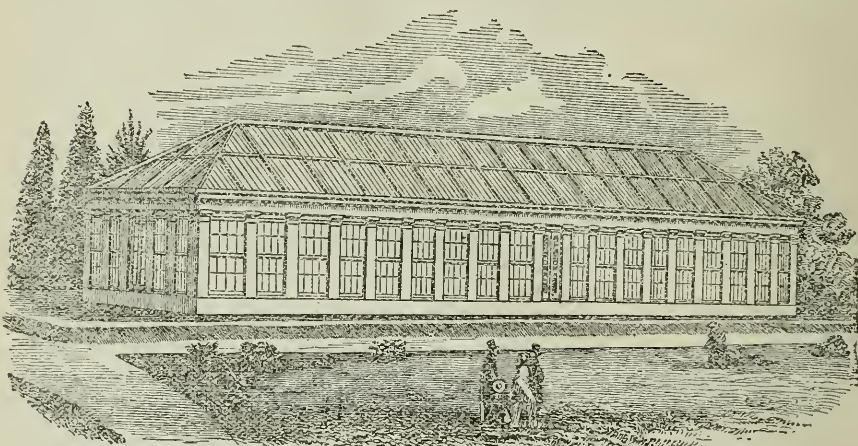

FIG. 29.—Conservatory made of sash, style of 1858 (Hovey's Magazine).

Much attention was attracted to these methods of construction by the animated discussion in various magazines as to whether they were of American or English origin. The editor of the Magazine of Horticulture, Mr. C. M. Hovey, stated that he had been using the system for twelve years prior to 1850, but it is evident from his writings that he was not aware of the publications referred to. Unquestionably, the methods did not originate with any one man or set of men, but were the direct outcome of the progress of the times. Largely through the efforts of Mr. Hovey and Mr. William Saunders, however, they were brought into prominence and soon came to be generally adopted. (See fig. 29.)

[1] Gardeners' Chronicle, 1843, Vol. I, p. 53.

At this time there seems to have been a marked sentiment toward the purely architectural in greenhouse construction, and it is therefore not surprising to find some houses in which utility was sacrificed to architectural effect. Such things, however, were more common among private individuals than in the case of commercial growers.

By 1860 commercial floriculture and the forcing of vegetables had assumed important proportions, the latter as yet being confined almost entirely to hotbeds. The breaking out of the civil war checked the work, however, and but little progress was made for the next six or eight years.

AN ERA OF PLANT GROWING.

When business had assumed something of its normal condition after the close of the civil war there was a marked interest in plants both for bedding and decorative purposes. Many establishments were

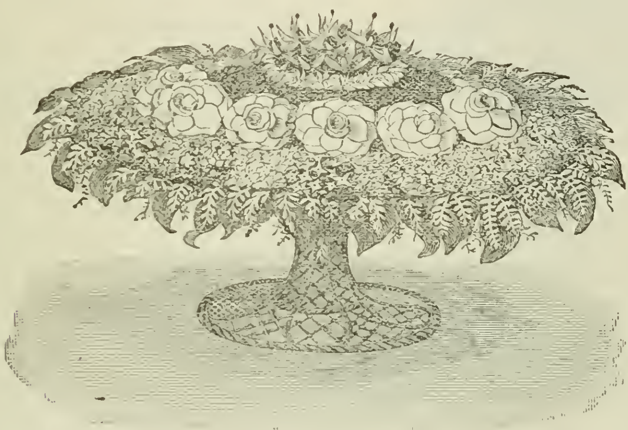

FIG. 30.—Basket of flowers in fashion in 1857 (Henderson's Practical Floriculture).

therefore started for the purpose of growing such plants, and there was a revival of interest all along the line. It was at about this period (1865–1868), furthermore, that vegetable growing under glass began to attract more widespread attention. Boston had long been the center of this important industry, but, as already pointed out, it was confined almost entirely to hotbeds and frames. Recognizing the inadequacy of their methods, however, a few of the more progressive growers in the vicinity of Boston took the sashes used for hotbeds and made houses of them.

It had long been the belief among gardeners that to properly grow lettuce it must be near the glass; hence, the first houses built for this crop were low, flat affairs, with barely sufficient head room to permit a man to walk erect. Another crop which had long been grown in frames was violets, the belief being that they had to be near the glass. The rigor of the climate made this method impracticable in many sections, and pits or low-roofed houses made of sash came into use about the year 1864 or 1865.

The demand for plants in preference to flowers was not lasting; hence, we find many changes, made necessary by the advances of the times. Retail dealers were becoming more numerous, but at this time no one dreamed of the remarkable influence they were to have on the future of the industry. The taste of the time in the matter of flowers ran mostly to bouquets and set pieces of the most formal types (figs. 30 and 31). A collection of the various styles of bouquets in use in 1868 to 1870 if exhibited to-day would probably attract more attention on account of their oddity of form and formal construction than any of the artistic decorations now seen in our florists' show windows. There was a mathematical exactness about the arrangement of each row of flowers which is seen nowhere at the present time in horticultural work, except possibly in the ribbon beds where foliage plants are grown.

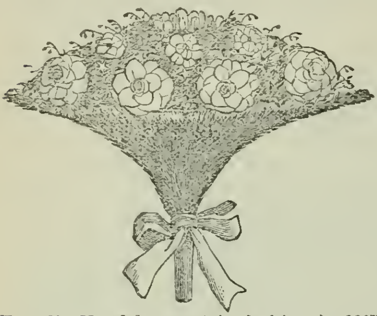

FIG. 31—Hand bouquet in fashion in 1867 (Henderson's Practical Floriculture).

Camellias were the principal flowers used, and what with wiring, toothpicking, and trussing up generally the making of bouquets was a very formal business. Notwithstanding this fad, which of necessity had to be catered to by the trade, there were true artists who understood and appreciated the beauty of the flowers themselves and the possibilities in arranging them more in harmony with nature's teachings. The true lovers of flowers have always been the ones to improve the public taste in the matter of arrangement, and we now find everywhere that those who succeed best in the business are people of this kind.

It was at this time (1866) that the first important book on floriculture[1] appeared, and being thoroughly practical, it awakened widespread interest in the growing of plants under glass.

AWAKENING DEMAND FOR CUT FLOWERS AND WINTER VEGETABLES.

By 1870 there were several thousand commercial establishments in the United States devoting their entire attention to the growth of plants for decorative purposes, for bedding, and for flowers, and to the growth of vegetables for winter use. The growing of vegetables was as yet a comparatively small industry, embracing probably less than one-tenth of the amount of glass devoted to plants and flowers. The increased demand for flowers was marked at this time. Camellias, tuberoses, and such flowers had seen their day, and roses, carnations, violets, and chrysanthemums were superseding them. The rose,

[1] Peter Henderson: Practical Floriculture.

however, was the principal flower, and much attention was given to improved forms and the methods of growing them.

With the ever-increasing demand for better stock, more improved methods of constructing houses naturally followed. The cumbersome structures of heavy timber and small glass gave way to houses better lighted, better heated, and better constructed in every way. Steam, which had its advocates years before, began to attract widespread attention in heating commercial establishments, and it was not long before it commenced to take the place of hot water in many sections.

With the great increase in the demand for cut flowers, growers who had been devoting their glass to miscellaneous stock made haste to transform their establishments into veritable factories for turning out roses and other flowers. The keenness of competition in this kind of work quickly led to the necessity of concentrating energy upon a few crops, and thus was evolved the specialist.

AN ERA OF SPECIALIZATION.

Specialization assumed considerable importance as early as 1875, and from that date to the present time its development has been phenomenal. The change from the old methods was, of course, gradual, as has been shown, and can be brought out sharply only by a comparison of the work in different epochs. Roses were still the leading crop, but carnations, violets, and chrysanthemums were coming into prominent notice. The varieties of roses were constantly changing, the popular demand for any one lasting scarcely more than a few seasons, and the number of varieties grown commercially was greater than at present. With the demand for long stems and the necessity of being able to control growth at all times came the evolution of the present methods of growing roses on shallow benches.

Between 1875 and 1880 Southern-grown vegetables began to have a marked effect on Northern markets. In order to compete with the Southern growers better facilities in the way of forcing houses were necessary; hence, wide and high steam-heated houses came into use. Most of these houses were erected in the vicinity of Boston, and were at first of the lean-to type. They were from 20 to 25 feet wide and 10 to 12 feet high at the back, with the slope to the south side, where there was a 5-foot wall, the upper half of which was of ventilating sash. Many houses of this type were erected around Boston and Providence and some were put up near New York.

Owing to the increased demand for greenhouses and the fact that it was no longer possible for ordinary carpenters and builders to keep pace with the times, companies were organized which devoted special attention to greenhouse construction, some of them having been engaged in the manufacture of boilers and other apparatus used in connection with greenhouse work. Competition in such lines was developed early, and in all cases this had a tendency to greatly advance the work.

What proved to be a marked impetus to horticultural work was the organization at this time of the Society of American Florists, which held its first meeting in 1885. In looking back over the history of plant growing under glass it is not difficult to trace the marked influence of well-organized societies in advancing the interests of those engaged in any line of work. In the earlier days, as already pointed out, it was the societies near Philadelphia that gave that city preeminence in horticultural lines, and it is surprising that there should have been at that period, and even now, such apathy on the part of many florists toward society work. Association is essential to the advancement of business, and every effort put forth toward increasing membership and keeping the members interested is so much toward increasing trade and advancing business generally.

At the first meeting of the Society of American Florists the president, Mr. John Thorpe, gave some authentic facts, of a statistical nature, relating to the work of growing plants under glass. He states that the actual number of flowers produced at this time (1885) was almost incredible. To his personal knowledge nine growers of roses sent to New York 4,000,000 flowers, and yet this was not 50 per cent of the roses sent to that market alone. He estimates that the aggregate number of roses grown around Boston, Philadelphia, Cleveland, Chicago, Washington, and in all other places could not have been less than 24,000,000. The number of carnations grown was at least five times greater, or about 120,000,000. He estimated, furthermore, that at least one-fourth as many roses and carnations were grown by private establishments and represented as much value as if they were thrown on the market. The amount of space occupied by flowering plants and bulbs in the open air was estimated to aggregate at least 12,000 acres, in addition to several thousand acres used for seeds.

In 1885 the American Florist, a journal devoted to floriculture, appeared, and shortly after the Florists' Exchange, a trade paper.

In 1888 another innovation in greenhouse construction was inaugurated, that is, the use of iron framework. This is the latest and unquestionably the best form of construction, and it came rapidly into use. Although the first cost of construction is higher for an iron house, its durability is so much greater that it is the cheapest in the end.

According to Mr. W. A. Burnham, an experienced greenhouse constructor, the first iron greenhouse was erected in 1881, but such houses did not begin to attract general attention on the part of commercial growers until 1888, as already stated. Rapid improvements had also been made as regards the glass used, the small sizes having been abandoned and glass 16 by 24 inches and even 16 by 30 inches being

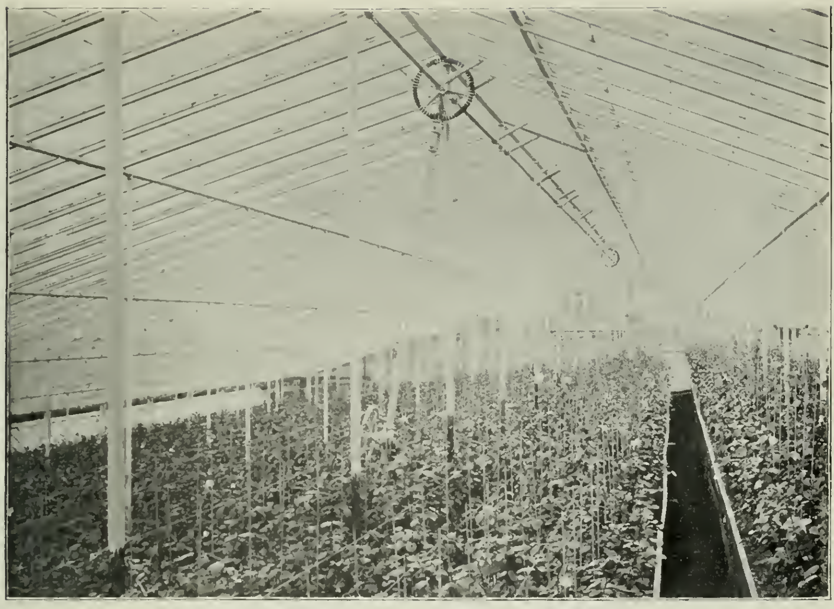

FIG. 1.—MODERN ROSE HOUSE.

FIG. 2.—RETAIL FLOWER STORE.

FIG. 1.—TOMATO HOUSE.

FIG. 2.—LETTUCE HOUSE.

FIG. 1.—CARNATION HOUSE (INTERIOR VIEW).

FIG. 2.—CARNATION HOUSES (EXTERIOR VIEW) AND CARNATIONS IN THE FIELD.

generally adopted. All these improvements tended to the production of higher grades of plants and flowers by increasing the amount of light and greatly multiplying the possibilities of the grower. (Pl. LI, fig. 1.)

The growers of vegetables under glass also found it necessary to increase the size of their houses, thus relatively cheapening them and at the same time changing the form to better meet the requirements suggested by experience. The plain lean-to type was in a measure abandoned and a modified three-quarter span began to come into general use. Houses 35 and 40 feet wide were found to have advantages over narrower ones, and in many cases they were made 300 to 400 feet long. (Pl. LII.)

There was a rapid increase in the number of retail florists' establishments, especially in cities, and many of the retailers had given up growing flowers, having found it to their advantage to devote their entire time to the management of retail business. The carnation was coming into more prominent notice, and it was given a great impetus in 1891 by the formation of the American Carnation Society, an organization which has done much to cultivate a taste for one of our most beautiful flowers. (Pl. LIII.)

PRESENT STATUS OF THE INDUSTRY.

The growth of the industry for the past few years has been remarkable. As a rule, the improvements in methods of producing and handling the crops have kept pace with the improvement of the crops themselves Competition is so keen that specialization has been carried into details which a few years ago were not thought of. In the handling of cut flowers and plants retail dealers play an important part. Many of these men, as already pointed out, are not producers at all, but depend wholly on producers and wholesale dealers for their stock. The retail stores in the large cities are models of artistic elegance (Pl. LI, fig. 2) and do much toward developing a taste for the highest ideals in floricultural effects; hence, it is not surprising to find the business as a whole divided into many special fields. Houses, frames, boilers, and other accessories are now made by specialists, and cut flowers are grown by specialists and handled by wholesalers and retailers who are specialists. What is true of cut flowers is also true, with certain exceptions, of both ornamental and bedding plants.

A number of special works on floriculture and vegetable culture have appeared, and a third journal, the Florists' Review, is published to meet the wants of growers, wholesalers, and retailers of flowers and plants.

It is a difficult matter to reach even approximate conclusions as to the amount of capital invested in the work, the value of the products, etc. A careful investigation of the question has been made by means of a special circular of inquiry, and also through representative men in various parts of the country. More than 12,000 copies of the circular referred to were sent out, but for one reason or another the returns were not very satisfactory. From all the data at hand, however, we are led to believe that there are now in the United States not less than 10,000 commercial establishments devoted to growing plants under glass. Of this number, probably 1,000 are engaged exclusively, or nearly so, in the forcing of winter vegetables, such as lettuce, cucumbers, tomatoes, and some minor crops. Within 15 miles of Boston there are probably not less than 40 acres of glass, or 1,742,400 square feet, devoted to vegetables alone. Two-thirds of this is in houses, the rest being in hotbeds and frames. Around Providence, R. I., there are probably not less than 10 acres of glass, while the amount devoted to vegetable growing about New York, Chicago, and other cities will bring the total up to 100 acres, or about 4,500,000 square feet. Including all equipments, such as boilers and other accessories used in connection with the industry, this glass represents an average value of not less than 50 cents per square foot, or $2,250,000 in all, and this will bring to the grower 50 cents per square foot annually, or $2,250,000 from the producers' standpoint. Nine-tenths of the products are sold at retail, either by the grower himself, or by the retailer, who may not be a grower. The valuation from this standpoint represents double what it is from the standpoint of the wholesaler, or $4,500,000 for forced vegetables.

Summarizing the forcing of vegetables under glass in the United States, therefore, we have the following:

Number of square feet devoted to the industry	4,500,000
Value of establishments	$2,250,000
Wholesale value of annual product	$2,250,000
Retail value of annual product	$4,500,000
Number of men employed	2,250

There are probably not less than 9,000 commercial florists' establishments in the United States. Some of these contain areas of glass which cover acres, while others contain only a few hundred square feet. Taking the country as a whole, it is estimated that there is an average of 2,500 square feet of glass for each establishment, or 22,500,000 square feet in all. New York has the largest number of establishments, there being not less than 1,100 or 1,200, with glass amounting to nearly 4,500,000 square feet; Illinois, with 600 to 800 establishments and over 4,250,000 square feet of glass, is second; while Pennsylvania, with 800 or 900 establishments and about 4,000,000 square feet of glass, is third. The estimated value of the establishments in this country, including houses, boilers, and all fixtures, is placed at 50 cents for each square foot of glass, or $11,250,000 in all. The income to the producer will average 50 cents per square foot annually, or $11,250,000, and double that amount when viewed from the standpoint of the retailer. Considering the matter from the retailer's standpoint, therefore, the total value of the annual output is $22,500,000, or $1 for each square foot of glass.

It is estimated that the retail value of cut flowers sold annually is $12,500,000, the estimated apportionment of this sum being, for—

Roses	$6,000,000
Carnations	4,000,000
Violets	750,000
Chrysanthemums	500,000
Miscellaneous flowers, including lilies, etc	1,250,000

Estimating the average retail value of roses, carnations, and violets at $6, $4, and $1 per hundred, respectively, the total number of each sold annually, based on the above values, would be, of—

Roses	100,000,000
Carnations	100,000,000
Violets	75,000,000
Total	275,000,000

The retail value of the plants sold is placed at $10,000,000. Taking the plant trade as a whole and the country in the aggregate, the average-sized pot used is estimated to be 3 inches, and the average retail price 10 cents per pot. This means that there are no less than 100,000,000 plants sold every year.

To handle this business in its entirety requires probably an average of not less than one man for every 1,500 square feet of glass, or 15,000 men in all. Fifteen hundred square feet of glass per man may seem like a low estimate, and such is the fact when considering commercial establishments of any size. The larger the area of glass, other things being equal, the more square feet one man can handle. As a matter of fact, some of the large rose-growing establishments do not use more than one man for each 10,000 square feet. Large carnation establishments will run about the same as roses, while violets, owing to the great amount of work involved in cleaning the plants and picking the flowers, average higher. It is the many thousand small establishments that increase the amount of labor required.

CONCLUDING REMARKS.

It is fitting in conclusion to call attention to some of the modern methods of handling and disposing of the vast amount of material produced by the establishments in question. Some references have already been made to this matter, but they are of a general nature only.

Many of the crops grown pass through several hands before reaching the consumer. Some of the larger establishments, especially those devoted to vegetable growing, dispose of their products through special agents, who receive a salary for this work, and are expected to keep in close touch with the markets and look after every detail, so as to obtain the highest price for the material handled. That such a method pays and pays well is evident from the fact that some of these agents receive salaries exceeding any paid by ordinary business establishments except in very special lines.

Auction sales are another important innovation which enables the plant grower to dispose of much of his stock. Within the past few years these sales have become quite popular, and have done much toward broadening the opportunities for work, especially in plant growing.

A vast amount of stock, especially cut flowers, is now handled by wholesale commission houses, which are to be found in nearly all the large cities. These houses have every facility for the rapid handling of flowers, and afford to the growers an opportunity of disposing of stock which a few years ago was not possible. Some of these wholesale men are already finding it necessary to specialize, and for this reason are making reputations for having on hand the best in the market in the way of roses, violets, or whatever their specialty may be.

In addition to wholesale commission houses, there are in some larger cities cut-flower exchanges, which handle a great deal of stock. These exchanges are controlled and managed largely by growers themselves, and are conducted as nearly as possible on an equitable basis. The New York Cut Flower Exchange has been in existence for five or six years, and its success has been quite marked. It has for its supporters some of the best growers in the Eastern United States, and the prices received through this cooperative plan are said to be very satisfactory.

In close touch with the commission houses and exchanges are the retail stores, which are by far the most important factors in connection with this business in the matter of handling and disposing of stock. The amount of flowers and plants handled by these establishments in some of the large cities is almost incredible. Undoubtedly, the annual sales of some of the best establishments of this kind in New York City will not fall short of three or four hundred thousand dollars. The stores themselves are looked after with the greatest care, every attention being given to the satisfying of artistic desires on the part of the customers. As already pointed out, the successful men in this business are those having sufficient artistic ability not only to cater to the demands of the customers, but to create new fads. The arrangement and handling of the flowers, the boxes, ribbons, delivery wagons, messenger boys, and every detail must be of the most artistic kind in order to attract attention and draw trade.

It frequently happens that, owing to circumstances, quantities of flowers are left on the hands of wholesalers, commission men, and others. Most of this material is now disposed of to a class of men known as street fakers, who often play an important part in relieving the pressure on an already full market. These fakers are to be found everywhere in large cities, and, with their push carts and other facilities for locomotion, they are doubtless able to supply a class of trade that could not be reached in any other way.

Through the trade journals growers, wholesalers, and retailers are kept in close touch with each other. These journals are published weekly, and each has its staff of special correspondents, who watch the markets and call attention to every detail worth noting. A review of the market reports in them for the past ten years brings out some interesting points. For instance, by averaging their weekly quotations from January, 1890, to December, 1899, it is seen that while there has been an enormous increase in the production of cut flowers, prices have not decreased as much as would naturally be expected. The following table shows the average prices received for roses, carnations, and violets in four of the principal markets during the period named:

Average wholesale price per 100 of roses, carnations, and violets, from 1890 to 1899, inclusive, in the four principal cut-flower markets.

Market.	Roses.a	Carnations.	Violets.
Chicago	$5.65	$1.63	$1.09
Boston	6.55	1.61	.84
Philadelphia	6.29	1.48	.87
New York	4.32	1.35	.89
General average	5.70	1.51	.92

a The American Beauty rose is excluded from this estimate on account of the high price it commands in comparison with other varieties.

It will be seen by this table that Chicago leads in the prices of carnations and violets and that Boston stands at the head in the prices quoted on roses. The change in prices for the past ten years is shown in the following table, the averages being given for two periods of five years each:

Average wholesale price per 100 of roses, carnations, and violets, in five-year periods, from 1890 to 1899, inclusive, in the four principal cut-flower markets.

Flowers.	Chicago.	Boston.	Philadelphia	New York.
Roses:				
1890-1894	$6.77	$7.11	$6.57	$5.10
1895-1899	4.52	6.00	6.01	3.56
Carnations:				
1890-1894	1.85	1.73	1.61	1.65
1895-1899	1.49	1.53	1.40	1.17
Violets:				
1890-1894	1.17	.93	.60	1.07
1895-1899	1.01	.74	.73	.71

The following table shows the percentage of decrease in prices during the past five years as compared with the previous five:

Percentage of decrease in wholesale prices of roses, carnations, and violets, from 1895–1899, as compared with those received from 1890–1894.

Market.	Roses.	Carnations.	Violets.
	Per cent.	*Per cent.*	*Per cent.*
Chicago	33	19	9
Boston	16	12	20
Philadelphia	8	13	*a* 22
New York	30	29	34

a Increase.

Viewing the work as a whole and considering its marvelous development, it stands out as one of the most striking examples of the advance of wealth and culture. The increasing love for flowers denotes a growing refinement and a higher appreciation of all things artistic, which promises well both for the individual and the nation.

RISE AND FUTURE OF IRRIGATION IN THE UNITED STATES.

By Elwood Mead,

Expert in Charge of Irrigation Investigations, Office of Experiment Stations.

REMAINS OF ANCIENT IRRIGATION WORKS.

The earliest pathway of civilization on the American continent led along the banks of the streams. In various parts of the Southwest, notably in the Salt River Valley of Arizona, in northern New Mexico, and along the southern borders of Colorado and Utah are well-defined remains of irrigation works which have outlived by many centuries the civilization to which they belonged. In at least one instance the bank of an ancient canal has been utilized as a part of modern works.

Riding up the valley of the Rio Grande, in the first half of the sixteenth century, Spanish explorers found in the midst of arid surroundings beds of beautiful roses, "not unlike those in the gardens of Castile," as they noted in their diaries. They also found Pueblo Indians irrigating the thirsty soil, as their forefathers had done for centuries before them and as their descendants are still doing to-day. In this valley and along the tributary streams, and at other places in the desert wastes of the Southwest, Spanish settlements sprung up and maintained themselves by means of these life-giving waters. The ditches at Lascruces, N. Mex., have an unbroken record of three hundred years of service, the history of which is written in the banks of the canals and in the fields irrigated. This is due to the sediment with which the waters of the Rio Grande are laden. Year after year this has slowly added layer on layer to the sides and bottoms of these ditches, until from being channels cut below the surface of the soil they are now raised 2 or 3 feet above. It is here that one can yet find agriculture almost as primitive as that of the days of Pharaoh, where grain is reaped with the sickle and thrashed by the trampling of goats.

EARLY IRRIGATION IN CALIFORNIA.

From these settlements and from the conquered cities of Mexico adventurous missionaries pushed their way still farther westward until they came in sight of the Pacific, teaching the Indians the crude art of irrigation, which they had learned either in Spain or of the simple inhabitants of the interior, and making oases of bloom and fruitage among the hills and deserts of the coast. So came the early churches and gardens of California and the first small impulse toward the conquest of its fertile soil, which must always be gratefully associated with the memory of the Mission fathers.

Measured by their cost or the skill required to construct them, the small, rude furrows which watered these gardens are now of little importance. Compared to the monumental engineering works which have succeeded them, they possess to-day but little interest. The best preserved of these Mission gardens is now an insignificant feature in a landscape which includes miles on miles of cement-lined aqueducts, scores of pumping stations, and acres on acres of orange and lemon orchards, cultivated with thoroughness and skill not surpassed in any section of the Old World or the New. It was far different at the end of the eighteenth century, when the thirty or more of these gardens which were scattered along the coast between the Mexican border and San Francisco were the sole resting places of weary travelers and their fruit and foliage the only relief in summer from the monotonous landscape presented by the brown and arid hills which surrounded them on every side. They were under those conditions not only successful centers of influence from which to carry on the Christianizing of the Indian tribes, but forces tending to break up the migratory impulse by the establishing of homes among the early Spanish explorers.

BEGINNINGS OF MODERN IRRIGATION.

For the beginnings of Anglo-Saxon irrigation in this country we must go to the Salt Lake Valley of Utah, where, in July, 1849, the Mormon pioneers turned the clear waters of City Creek upon the sun-baked and alkaline soil in order that they might plant the very last of their stock of potatoes in the hope of bringing forth a crop to save the little company from starvation.

Utah is interesting not merely because it is the cradle of our modern irrigation industry, but even more so as showing how important are organizations and public control in the diversion and use of rivers. Throughout the pioneer period of their history the settlers of Utah were under the direction of exceptionally able and resourceful leaders, who were aided by the fact that their followers were knit together by a dominating religious impulse. These leaders had the wisdom to adapt their methods and shape their institutions to conform to the peculiar conditions and environment of a land strange and new to men of English speech. They found that irrigation was necessary to their existence in the home that they had chosen, and that the irrigation canal must therefore be the basis of their industrial organization, which was largely cooperative; hence, the size of their farms, which are less than 30 acres upon the average, the nature of their social relations, which are close and neighborly. (Pls. LIV and LV show some methods of irrigation and the improvement following the irrigation canal.)

FIG. 1.—THE FIRST IRRIGATION.

FIG. 2.—A LATER IRRIGATION.

FIG. 1.—APPEARANCE OF IRRIGATION CANAL WHEN FIRST COMPLETED.

FIG. 2.—APPEARANCE OF IRRIGATION CANAL TEN YEARS AFTER COMPLETION.

FIG. 1.—VIEW AT THE HEAD OF ONE OF THE EARLY IRRIGATION CANALS IN UTAH.

FIG. 2.—MOUNT UNION, FROM UNION PASS.

That the great material results which quickly followed could have been realized without the cohesion which came from an association dominated by religious discipline and controlled by the superior intelligence of the head of the Mormon Church, is doubtful; but that the character of institutions in the valleys of Utah, both industrial and social, was chiefly due to the environments in which they were placed is beyond dispute. Cooperation became the dominant principle simply because the settlers were in a land without capital, and it was beyond the power of the individual to turn the mountain current from its course and spread it upon his lands. Only the labor of many individuals, working under organization and discipline, could make the canals or distribute the waters. A small farm unit was chosen, not because men were less greedy for land than in all other new countries, but because it was quickly seen that the extent of the water supply was the measure of production, and their ability to provide this was small. Diversified farming, which is one of the leading causes of the remarkably even prosperity of Mormon agriculture, was resorted to because the Territory was so far removed from other settlements that it was compelled to become absolutely self-sustaining. The small farm unit made near neighbors, and this advantage was still more enhanced by assembling the farmers' homes in convenient village centers. One reason for adopting this plan, in the first place, was doubtless for protection against the Indians, but it has become a permanent feature, which is still adhered to in making new settlements because most satisfactory to the social instinct. (A view at the head of one of the early irrigation canals in Utah is shown in Pl. LVI, fig. 1.)

COOPERATIVE COLONIES IN COLORADO AND CALIFORNIA.

The discovery of gold in California created the Overland Trail, which wound its tortuous course across the hitherto trackless wastes of the arid domain. Its stations were usually along the banks of the streams. In the neighborhood of these, settlers had established themselves, and by means of simple furrows turned the waters of the streams upon the bottom land. This was the extent of irrigation throughout the vast region it traversed, outside of Utah, before the Union Colony at Greeley, Colo., became the second historic instance of the beginnings of the present system, and one which furnished a different standpoint for a study of the subject.

As Utah is the result of a religious emigration, so Greeley is the creation of the town meeting. Its founding marked the beginning of a new and different industrial development in Colorado. Before this it was the wealth of the mines or the migratory and adventurous experiences of the range live-stock business which had attracted settlement. Greeley, on the contrary, represented an effort of home-making people, both to enjoy landed independence and social and intellectual privileges equal to those of the towns and cities they had left. Among its first buildings was Colony Hall, and among its first organizations the Lyceum, in which all the affairs of the community were debated with a fervor and fearlessness quite worthy of Horace Greeley's following. Cooperation was adopted in the construction and management of public utilities, of which the irrigation canal was the first and most important. The wisdom and justice of making common property of the town site, the beauty and value of which could only be created by the enterprise and public spirit of all, was recognized and put into practice with satisfactory results. The only deliberate extravagance was the erection at an early day of a school building worthy of the oldest and richest New England community. The highest methods both of irrigation and cultivation were sought out through numberless experiments, until Greeley and its potatoes grew famous together. The home and civic institutions of the colony became the pride of the State, and the hard-won success of the community inspired numerous similar undertakings and furnished an impulse which resulted in the reclamation and settlement of northern Colorado. Boulder, Longmont, Loveland, and Fort Collins were the outgrowth of success at Greeley, and each adopted many of the ideas and tendencies of the parent colony.

Twenty years subsequent to the beginning of Utah, and contemporaneously with the settlement of Colorado, similar influences began to make themselves felt in California, especially in its southern part. Anaheim is called the mother colony. This was cooperative in its inception, and its principal irrigation system has ever remained such. Riverside followed a few years later and represented a higher ideal; but the spirit of speculation in which California civilization was born soon fastened itself upon irrigation, as it had done in the case of mining, and ran a mad race through southern California. Irrigation in this State became corporate and speculative. Where Utah and Colorado had depended only upon their hands and teams for the building of irrigation works, California issued stocks and bonds, and so mortgaged its future. Men began to dream of a new race of millionaires, created by making merchandise of the melting snows, by selling "rights" to the "renting" of water, and collecting annual toll from a new class of society, to be known as "water tenants."

CORPORATE CANAL BUILDING.

The investment of corporate capital in canals to distribute and control water used in irrigation began in California, but spread like a contagion throughout the West. For a quarter of a century it has been the leading factor in promoting agricultural growth of the western two-fifths of the United States. It has been the agency through which many millions of dollars have been raised and expended, hundreds of miles of canals constructed, and hundreds of thousands of acres of land reclaimed. It has built the largest overfall dam ever

FIG. 1. CANAL WASTE GATE CLOSED.

FIG. 2.—CANAL WASTE GATE OPEN.

placed in a large river. It has been the chief agency in replacing temporary wooden structures by massive headworks of steel and masonry, and has, by the employment of the highest engineering talent available and the introduction of better methods of construction, promoted the economy and success with which water is now distributed and used. The question which is now to be considered is how the vast fabric created through its agency is to be directed and controlled in order that it may not crumble of its own weight. (Pl. LVII.)

The construction of irrigation works by corporate capital came as a natural if not inevitable evolution. There came a time in the districts first settled when the opportunities to divert water cheaply had largely been utilized, and when the expenditure required was beyond the means of either the individual or the cooperation of many individuals. The preliminary outlay was too great. In older European countries experience has shown that no agency can be so wisely intrusted with these larger expenditures as the State. Large irrigation canals have been considered as being, in their nature, as much public improvements as are works to supply water to cities and towns. Being for the service of the public, those in older European countries have largely passed under public ownership.

In this country corporations have, so far as construction is concerned, taken the place of governmental agencies in other lands. Practically all of the larger and costlier works built within the last two decades have been of this character. The High Line Canal, which waters the land surrounding Denver, Colo., with its tunnel through the mountains and its aqueduct carried along the rocky cliffs below; the canals of the Wyoming Development Company, with its tunnel alone costing more than all the Greeley Colony canals combined, and its reservoir for storing the entire year's discharge of the Laramie River; the Sunnyside Canal of Washington, which when built traversed 60 miles of sagebrush solitude, are illustrations in three States of the nature of corporate contributions to irrigation development. Even in Utah, cooperation was not sufficient to reclaim all of Salt Lake Valley. For forty years the table-land north of the lake, one of the largest and best tracts of irrigable land in the valley, remained unoccupied, while the sons of the pioneers were compelled to seek homes in the surrounding States. To reclaim this land, a canal had to be carried for 3 miles along the precipitous sides of Bear River Canyon. The flow of the river had to be controlled by an extensive dam and the Malad River twice bridged by long and high aqueducts, and the million-dollar outlay required was more than home seekers could provide.

The creation of water-right complications came with the building of corporate canals. Previous to this it had been the rule for those who built ditches to own the land they watered, and there was little difference as to whether the right to water went with the ditch or with the land, because the ownership of both was united in the same person. But when companies were organized to distribute water for others to irrigate with and to derive a revenue from water rentals, there arose the question as to who was the owner of the right to the water diverted—the company transporting the water or the farmer who used it. The laws of nearly all the Western States make the ditch owner the appropriator. This has created a divided ownership of land and water, and many canal companies have framed water-right contracts on the theory of absolute ownership. These have proven a source of constant irritation to farmers. Some of these contracts require the farmer to pay, at the outset, a royalty or bonus for the "right" to receive water, the charge for this right varying from $5 to $500 per acre, depending on the scarcity of the water supply or the value of land and its products. There is a very prevalent feeling among farmers that as they are the actual "beneficial users" of the stream, they should be considered the appropriators, or at least that the owner of the land should share with the owner of the ditch in the right to water.

OBJECTIONS TO CORPORATE CANALS.

Having dealt with the benefits derived from corporate investments in irrigation works, it is now proper to point out their defects. The most serious one is that nearly all large canals have been losing investments. The record of these losses is so stupendous that it is reluctantly referred to. A single enterprise in one of the Territories represents to its projectors a loss of over $2,000,000. The Bear River Canal, in Utah, which cost over a million dollars, was recently sold under a judgment for about one-tenth of this sum. A single canal in California represents a loss to its builders of over $800,000. These are not isolated cases. Similar instances might be multiplied indefinitely. They are not due to bad management, to dishonesty, or faulty engineering. Some of the worst failures in a financial sense have been handled by the brightest and most experienced men in the West, but they were not able to make their enterprises pay, that is, they have not paid their builders. Nearly all have been a success so far as the section interested was concerned, but the benefits have gone to the public and not to the investors. The reasons for this should be more generally understood. The following are the most important:

(1) The necessarily long delay in securing settlers for the land to be irrigated and in obtaining paying customers for the water to be furnished.

(2) The large outlay and several years of unprofitable labor required, as a rule, to put wild land in condition for cultivation. Settlers of limited means can not meet this outlay and in addition pay water rentals. Nearly all of the settlers on arid public land are men of

limited means; hence, canal companies have at the outset to furnish water at small cost, or furnish to a small number of consumers.

(3) The unsuitability of the public-land laws to irrigation development.

(4) The acquirement of the lands to be reclaimed, in many instances, before canals are completed by nonresident or speculative holders, who would do nothing for their improvement.

(5) Expenses of litigation. Experience has shown that in the estimates of cost of a large canal provision should be made for a large and long-continued outlay for litigation. It begins with the adjudication of the stream and is protracted through the controversies over water rights.

WATER-RIGHT PROBLEMS OF THE ARID REGIONS.

After this brief sketch of the beginnings of American irrigation, some of the lessons of which will be considered at a later point in this article, we may appropriately turn to the great arid region as a whole and the complex legal, economic, and social problems with which its agriculture will vex the future.

Mount Union (Pl. LVI, fig. 2) rises in solemn grandeur in the Wind River Mountains of Wyoming south of Yellowstone Park. From this peak flow three streams, which, with their tributaries, control the industrial future of a region greater than any European country save Russia, and capable of supporting a larger population than now dwells east of the Mississippi River. These streams are the Missouri, the Columbia, and the Colorado. The first waters the mountain valleys on the eastern slope of the Rockies and the semiarid region of the Great Plains; the second, the Pacific northwest, including part of Montana, all of Idaho, and the major portions of Oregon and Washington; the third, the Southwest, embracing much of Utah and western Colorado, parts of New Mexico and California, and all of Arizona.

In this vast district, when reclaimed, homes may be made for many millions of people. To effect this result is a task inferior to no other in the realm of statesmanship or social economics. It is the nation's farm. It contains practically all that is left of the public domain, and is the chief hope of a free home for those who dream of enjoying landed independence, but who have but little besides industry and self-denial with which to secure it. As it is now, this land has but little value. In many places a township would not support a settler and his family, and a section of land does not yield enough to keep a light-footed and laborious sheep from starving to death. This is not because the land lacks fertility, but because it lacks moisture. Where rivers have been turned from their course, the products which have resulted equal in excellence and amount those of the most favored district of ample rainfall.

There are only 6,000,000 acres of cultivated land along the Nile. It is all irrigated. Where there is no irrigation there is desert. This little patch of ground has made Egypt a landmark in the world's history. It supports over 5,000,000 people and pays the interest on a national debt half as large as our own. The Missouri and its tributaries can be made to irrigate three times the land now cultivated along the Nile.

The essence of the problem to be met at the outset is the control and distribution of the water supply, since not only the enduring prosperity but the very existence of the homes created will be conditioned upon the ability to use these rivers for irrigation. The diverse interest of individuals and communities, and even of different States, will all be dependent on streams flowing from a common source. To reclaim all the land possible will involve the spreading of water over a surface as large as New England with New York added. Standing now at the birth of things and looking down the vista of the future, we can see in the course of these rivers the dim outline of a mighty civilization, blest with peace and crowned with a remarkable degree of prosperity, in case wise laws and just policies shall prevail in the years of the immediate future while institutions are forming. But if it be otherwise, if greed and ignorance are allowed to govern, and we ignore the experience of older countries than ours, there will remain to us only a gloomy forecast of legal, economic, and, possibly, even civil strife.

THE APPEARANCE AND RESOURCES OF THE ARID REGION.

In discussing this phase of the subject, let us follow the Missouri, Columbia, and Colorado rivers in their lonesome courses through mountains, plain, and desert to the place where one joins the Mississippi, where another mingles its waters with the Pacific, and where a third flows into the Gulf of California. For it is not only interesting but important to see in the midst of what surroundings so large a future population must dwell, and upon what other resources than water and land it will rear its economic edifice.

The climate of the western half of the United States takes its chief characteristic from its aridity, or dryness. The heat of its Southern summers and the cold of its Northern winters are alike tempered and mitigated by lack of humidity. Neither the humid heat which prostrates nor the humid cold which penetrates to the marrow is known in the arid region. The Western mountains and valleys are a recognized natural sanitarium where thousands of invalids are sent each year by physicians to regain their health.

The dominant feature in the physical appearance of the arid regions is its mountain topography. On every hand a rugged horizon meets the view. From North to South, from Canada to Mexico, the Rocky Mountain Range makes the backbone of the continent. Along the

Pacific coast the Sierra Nevada and Cascade ranges lift their barriers to intercept the moisture and condense it into snow. Between these two principal chains, with their connecting ranges and outlying spurs, are many minor systems, so that the whole country is a succession of mountains and valleys, of forests and deserts, of raging torrents and sinuous rivers winding to their sinks upon the plains or making their difficult way to the distant ocean. The far West is thus a land of the greatest scenic beauties, and widely celebrated as such.

The cultivable lands lie in the valleys, rising with gradual slope on either side of the streams to meet the foothills. Narrowing to the mountains, these valleys widen as the river loses grade and approaches the sea or its confluence with a larger stream. There are valleys which will accommodate hundreds, others, thousands or tens of thousands, and a few, like the Sacramento, in California, where millions may dwell.

In the eastern portion of the arid region, and in high altitudes farther west, the land is covered with nutritious natural grasses, which furnish ideal range for live stock. But the characteristic badge of the region is the sagebrush. This brave plant of the desert is commonly held in derision by those who behold it for the first time, and until they learn to know it as the shelter and dependence of range live stock when the terrible blizzard sweeps from the north and as the sure indication of good soil and the humble prophet of the field, orchard, and garden. Thus, it happens that to the casual traveler the appearance of the region is forbidding. It is only in localities where the work of reclamation has been in progress long enough to permit the growth of trees, with farms and homes, that the value of the soil and climate can be appreciated. There are such instances in all the seventeen States and Territories of the far West. One of the most striking is the Salt River Valley of Arizona. Here the traveler, after a long and tiresome journey through waste places, finds himself suddenly confronted with homes rivaling in taste and luxury those of Eastern States, and with orchards and gardens which resemble more the century-old gardens of France and Italy than a creation of the last twenty years.

Similar instances are the San Bernardino Valley of southern California, the Salt Lake Valley of Utah, and the Boise Valley of Idaho.

MINERAL WEALTH OF THE ARID REGION.

Another fact which contributes to the breadth of the economic foundation of Western agriculture is the variety and value of its mineral wealth. In this it is richly endowed, not only with the precious metals, but with the baser ones used in arts and industries, and with unusual quantities of coal, ore, and building stone, the latter of which includes many rare and valuable kinds, such as marble, onyx, and agate.

While the annual value of these products runs into the tens of millions of dollars, it is literally true that their development is yet in its infancy. With the extension of railroad facilities, the improvement and cheapening of mining processes, the extension of agriculture, and consequent increase in the volume and decrease in the cost of the home food supply, the gain in annual production will assume in the future dimensions which would now be considered beyond belief.

SOURCES OF FUTURE PERMANENT PROSPERITY IN THE ARID REGION.

To the mines must be added the forests which clothe the mountain sides, especially those of the northern part of this region. To a large extent this is still virgin ground, where only the foot of the hunter and explorer has trodden. It is a region unrivaled in its opportunities for the development of water power. The Shoshone Falls in Idaho are scarcely inferior to those of Niagara. The hundreds of streams which fall from the 10,000-foot level of the Rocky Mountain Range to the 4,000-foot to 5,000-foot level of the plain at their base are destined to turn more wheels of industry than have yet been harnessed west of the Mississippi River. Back of the irrigated lands are the grazing lands, of which there are probably not less than 400,000,000 acres. These lands have been the dominant factor of the pioneer life of many of the arid Commonwealths, and they are destined, under proper management, to always constitute the great nursery of cattle, sheep, and horses. The irrigated farm has back of it the mine, the furnace, and factory, and the civilization of Western America can not fail to have a prosperous and varied industrial life. Here there can be no one-sided development, no community exclusively devoted to the production of corn, wheat, or cotton, to manufactures, or to commerce. The farm, the stock ranch, the lumber camp, the mine, the factory, and the store are destined to grow up and flourish side by side, each drawing support from and furnishing sustenance to the others.

PRESENT AND FUTURE OF IRRIGATION.

The present situation, the results secured, and the tasks ahead in securing a wise disposal of the arid lands and in preventing the rivers from becoming an instrument of monopoly and extortion, will now be considered.

We are met at the outset by an entire absence of definite information. We do not know, nor is there any ready means of determining, how many irrigation works have been built. In many States no provision is made for their record. In only two States is this record even measurably accurate or complete. There may be 75,000 completed ditches, or there may be double the number, but either as to their number or as to the number of acres of land reclaimed thereby there is only surmise and conjecture. This, however, is known, that the highest priced and most productive farm lands on this continent are in the arid region; that the largest yield of nearly every staple crop has been obtained by the aid of irrigation; that not only has the growth of agriculture furnished a market for the factories of the East and supported the railroads which unite the two extremes of the country, but it is the chief resource of nearly every one of the arid States. Colorado leads all the States of the Union in her output of precious metals, but the value of the product of her farms is nearly double that of her mines.

In California it is the grain fields and orange orchards which support the majority of her industrial population and furnish the basis for her future material growth and prosperity. The beginnings of Utah were wholly agricultural, and without the irrigated farms the cities of that interior Commonwealth would as yet be only a dream. In a less striking degree the same condition prevails in Idaho, Wyoming, Montana, New Mexico, and Arizona. This is the situation, while irrigation is as yet in its infancy. The reclaimed areas, though making a large aggregate, look very insignificant relatively to the rest of the country when delineated upon a map of the arid region. The possibilities of reclamation have but begun to be realized, yet when every available drop of water shall have been applied to the soil the irrigated lands will constitute a comparatively small proportion of the entire country. The possibilities of irrigation are, however, to be measured not alone by the possible extent of the agricultural industry, but by the development of other resources which it will make feasible. The best and largest use of the grazing lands, the utilization of the forests, the development of mines and quarries, and the maintenance of railroads and commerce in the western half of the United States, all hinge upon the control and use of streams in connection with the fundamental industry of agriculture. Since irrigation is essential to agriculture in the arid States, the extent and character of its development must surely measure the superstructure to be built upon that foundation.

GROWTH OF IRRIGATION AND NEED OF BETTER LAWS.

Some of the beginnings of irrigation have been referred to. The details of its growth can not be dealt with. It has been crude in many ways. There has been no attempt to provide for the diversion of rivers according to some prearranged plan having for its object the selection of the best land and the largest use of the water supply. Instead, each appropriator of water has consulted simply his ability and inclination in the location of his head gate. There has been an almost complete failure to realize that the time was coming when on many streams the demand would exceed the supply, and that a stable water right would be as important as a valid land title. The laws passed for recording claims are, as a rule, so loosely drawn and imperfect that they would be a source of amusement if the evil results of their operation were not so disastrous. More than half of the State laws provide for inaugurating a title to water by posting a notice on the banks of the stream. They have not aided the proposed appropriator, because the right to post other appropriations was unrestricted. They are of no use as a warning to others, because not one in ten thousand of the parties concerned ever see them. A search for these notices along the cottonwood borders of the Missouri and its tributaries would be the unending labor of a lifetime; hence, the requirement was and is ignored; it is another of the many influences tending to unsettle irrigators' just rights and bringing the attempts to frame laws for their protection into disrepute.

Looking over the field at the close of the century, we find that the United States stands practically alone among irrigation countries in having left all the work of reclamation to the unaided efforts of private capital, and in the prodigality of the surrender of public control of streams. In one respect the policy pursued has been successful. It has resulted in an enormous investment (not less than $100,000,000, and some estimates make it twice that sum) and the creation of taxable and productive wealth of many times the amount invested. We have now about reached the limit of this sort of growth. There will be few large private investments in canals hereafter until we have better and more liberal irrigation laws. Entrance on the coming century is confronted by larger problems; the storage of flood waters, the interstate division of streams, and the inauguration of an adequate system of public control, which will insure to the humblest handler of a shovel his share of the snows falling on mountains above his farm, no matter how far removed therefrom he may be.

NEED OF REFORM IN THE MANAGEMENT OF ARID PUBLIC LAND.

Along with better water laws should come a corresponding reform in the management of the remaining arid public land. At the outset of its settlement these problems were entirely new to English-speaking men.

Early settlers came from the humid portions of Europe and settled along the humid coast line of the Atlantic and, later, in the humid valleys of the Ohio and Mississippi rivers. The land laws which they applied to the public domain of their day produced excellent results, making homes for millions of people and effecting a wonderful development of material resources.

When settlement had proceeded under these laws to the Missouri River and beyond, it was not strange that their principles were extended to the remaining public domain, for the vast majority of the American people had no conception whatever of the conditions existing in the far West. Not only the national lawmakers, drawn mostly from regions of abundant rainfall, but the legislators in the arid States themselves were blind to the necessities of the situation. The value of gold they knew, but the value of that other element of national wealth, which will continue to sustain vast populations long after the last ounce of gold shall have been taken from the mine, they did not even dimly appreciate. So, to a large extent, they merely reenacted upon their statute books the common law of rainy and foggy England.

HOMESTEAD LAW NOT ADAPTED TO THE ARID REGION.

The homestead law may have served a useful, even a beneficent, purpose throughout large sections of the Republic, but it is not adapted to the settlement of a region where practically nothing can be grown except by artificial application of water. This fact has been learned at last through many years of hardship and disappointment, at the cost of many million dollars. One of the most pitiful pages in the history of the West is that which records the story of the settlement of the semiarid belt lying between the ninety-seventh meridian and the foothills of the Rocky Mountains. This is a territory 500 miles wide, extending from Canada to Mexico, including the western portions of the two Dakotas, Nebraska, Kansas, and Texas, and also eastern Colorado. In the absence of scientific demonstration to the contrary, tens of thousands of people rushed into this territory under the delusion that it was a land of reliable rainfall, or would soon become such as the result of settlement and cultivation.

New settlements sprung up in every direction, and important towns arose almost in a night. Men hastened from all parts of the country to claim their rights under the homestead law. Remembering the prosperity which similar armies of settlers had wrung from the virgin soil of the West, unlimited capital lent willing support to this new outward surge of growing population. The capital was largely lost, but the pathetic side of the picture was seen in the bitter disappointment of the settlers themselves. Many of them wasted the most useful and pregnant years of their lives in their brave persistence in the belief that the climate would change as the land came under cultivation, and that there was some magic potency in the homestead law to overcome the processes of nature. It is recognized at last that where water sufficient for purposes of irrigation can not be had the land is useful only for grazing. It is a mistake for the Government to offer to citizens land of that character on condition that they will settle upon 160 acres of it and make a living. There can be but one of two results—either the settler must fail or he must become practically the tenant of the person or corporation furnishing water for his dry land.

OPERATIONS OF THE DESERT-LAND LAW.

The desert-land law was devised to promote the investment of capital rather than to encourage settlement. For this reason it did not require actual residence on the land reclaimed. Originally, whoever would irrigate 640 acres of land was given title thereto on the payment of the Government's price. Later this acreage has been reduced to one-half the original area. The operation of this law has been both useful and injurious. To give so large an area to men of small means is a mistake, because it is more than is needed to make a home and more than they can cultivate. It is not suited to corporate enterprise, or to reclaim large valleys which can be watered from a single canal, because it makes no provision for concerted or effective management of the entire area. Its field of effective usefulness has therefore been limited. While it has added somewhat to the taxable and productive wealth of Western States, it has also operated to transfer to single owners miles of water fronts which without this law would have been divided up into smaller farms with better social and agricultural conditions.

THE CAREY ACT.

What is popularly known as the Carey Act, from the name of its author, Senator Carey, gives to each State the right to segregate 1,000,000 acres of land and to control both its reclamation and disposal to settlers. The limitations of the operations of this act confine its benefits simply to the opportunity to secure better management during the time of canal building and settlement. Five States have accepted the trust, but in only one, Wyoming, have any canals been completed. These canals have been built by companies operating under a contract with the State. In Montana it is proposed to construct State canals from money obtained by selling bonds secured by the land to be irrigated. Enough progress has not as yet been made to determine whether or not this innovation on past irrigation methods is to meet with success; if it does, the third step in the evolution of canal building, which is the construction of State works, will have been inaugurated.

INFLUENCE OF THE RANGE INDUSTRIES.

To a certain extent there is an inevitable conflict between those who wish to use the public domain for homes and those who prefer to have it reserved for pasture, and, again, between those who wish to use the pasture for cattle and those who want it for sheep.

The range industries obtained possession of the field long before the higher utility of the lands for irrigation and settlement was generally appreciated. When irrigators did come, they worked more or less injury to the range stockmen, for each settler occupied a part of the water front and added to the number desiring to use the free grazing land. It is for the interest of the range-stock industry that access to streams be made as free as possible and that nothing be done to reduce their volume or prevent the overflow of natural meadows, while the higher interest of irrigation and settlement demands that the stream be diverted and its waters distributed over the widest possible area. The conflict is between the wasteful use of water on the one hand and its economical use on the other, and, in a sense, between a primitive and a more highly organized civilization.

This statement should not be construed as denying that the range-stock industry is of vast importance nor that it will continue to be a great source of wealth to the country. Throughout the West there are very large areas suited to nothing else. The point is that the higher interest of society lies in the most economical and profitable use of water to the end that homes may be made for the largest possible number. Neither water nor land laws have favored this result, but precisely the contrary. The object of reform should be to preserve and develop all interests, to adapt laws and institutions to the peculiar conditions and environment of the region. This can be done with far greater security to the pastoral industries than they enjoy under the present system, and at the same time land and water available for making homes and farms utilized to the best advantage.

UNCERTAINTY AS TO STATE AND FEDERAL JURISDICTION.

The pioneers of irrigation are menaced by the uncertainty which exists as to the limits of State and federal jurisdiction in the control of streams. It has heretofore been assumed that the authority of each State within its borders was unquestioned, and two of the States contain constitutional provisions asserting absolute ownership and control of all the waters within their bounds. A recent decision of the United States circuit court in Montana holds this view to be erroneous, and that the snows which fall on public land and the streams which cross it are both under the control of Congress. A similar complication has arisen in litigation over a reservoir on the Rio Grande, in which both interstate and international rights are involved. In this case the United States Supreme Court has asserted the right of the General Government to protect the interests of navigation regardless of State statutes respecting the use of water in irrigation. The assertion of the paramount importance of riparian rights and of the protection of navigation, regardless of the use of water in irrigation, will add greatly to the uncertainty regarding water rights from the tributaries of the Missouri or any other of the rivers navigable in any portion of their course. The reclamation of the arid region involves the absorption of streams, and it can not be settled too soon whether or not such absorption is to be permitted.

COMPLICATIONS FROM LACK OF UNIFORM WATER LAWS.

On the other hand, serious complications have arisen from the absence of any general or national regulations governing the division of water across State lines. There are many instances where one stream is a common source of supply to irrigators in two or more States. It has sometimes happened that the perennial flow of such streams has been first appropriated in a State along its lower course and utilized at a later period by other States near its source. Neither of the States concerned possesses power to remedy the evil, and each makes claim to all the water flowing upon its soil.

The conditions which govern irrigation throughout much of the arid region are practically uniform, and where this is true there is no question that a uniform irrigation law would operate with equal justice and efficiency; but, owing to the absence of such general supervision, water rights in States adjacent to each other are often as different in character as if these Commonwealths were on opposite sides of the globe. Failure to correct or regard these complications aggravates the evils to which they give rise and renders the ultimate adoption of a uniform system of laws far more difficult. There is but one thing the States have shared in common, and that is endless litigation over water rights. There is no uniformity of laws or decisions. The same issues are tried over and over again, and the precedent established in one case is overturned in another. The construction of costly works, and even the long use of water, has not always been sufficient to secure parties in their rights. Where rights have been successfully maintained, it has been done only at the price of constant lawsuits.

Usually the amount of water claimed is many times in excess of what the projected canal can utilize; frequently in excess of the entire volume of water in the stream. There is no one to protect the public interest as to the character of works to be built or to say whether they conform to good public policy. The courts confirm these loose appropriations, and the foundation for endless litigation is thus securely laid. The question soon arises as to who first appropriated the waters which do not suffice for all. There is then nothing to fall back upon except the faulty filings which were originally posted on the banks of the stream and the testimony of interested citizens. It frequently happens that old claims for very large amounts of water have not been utilized to their full extent until later comers have appropriated the unused surplus. The old claim is then enforced at the expense of the later one. The result is confusion, loss, and bitterness among neighbors.

The difficulty lies, first of all, in popular misconception regarding the nature of water rights and of property in water. This is enhanced by lack of scientific information concerning the character and extent of water supplies and of the amount required for beneficial irrigation. Still further, there is a great need for a different system of appropriating waters and of distributing a common supply among consumers. These delicate and complex issues can not be fought out among private parties without producing a condition of virtual anarchy, in which the weak must go down and the strong survive, regardless of their merits or necessities. The failure of the irrigation industry from the financial standpoint is almost wholly due to the illogical land and water laws which have been described.

METHODS AND MEASURES NEEDED TO DEVELOP THE ARID REGION.

It is well to consider now by what methods and by what measures of legislation the splendid resources of the arid region may be opened to development.

The first step is to determine the proper control and just distribution of the water supply. The problem varies with different portions of the arid region. In the South, streams are generally torrential in character, furnishing the bulk of their waters in heavy floods, which must be stored in the many natural sites available in the mountains at a distance from the places where the water is to be applied to the soil. In the North, on the other hand, the problem is not that of storage, but of the diversion of great rivers like the Yellowstone, the Snake, the Columbia, and the Missouri. Here works adequate to the reclamation of the areas of arid land which remain can only be built at great cost, rivaling those along the Ganges and the Nile.

Before such development proceeds further it is desirable that some common agreement should be reached concerning the true character of water rights. The idea of private ownership in water apart from the land can not prevail without creating institutions essentially feudal in character. A water lord is even more undesirable than a landlord as the dominant element in society. It is indisputable, as has already been said, that the man who owns the water practically owns the land. A proposition which contemplates the turning over of all the land to a private monopoly, thus making a tenantry of those who may have their homes upon it in the future, could not hope to command popular support. But the idea of a private ownership of water, amounting to a virtual monopoly of this vital element, has been permitted to grow up in the West. To a certain extent it has obtained recognition in legislation and protection in judicial decrees and decisions. In other countries the doctrine has largely disappeared, and in our country it should give place to a more enlightened conception, and to the only principle that can safely be adopted as the foundation of the agricultural industry in the West.

The right to water which should be recognized in an arid land is the right of use, and even this must be restricted to beneficial and economical use in order that the water supply may serve the needs of the largest possible number. Ownership of water should be vested, not in companies or individuals, but in the land itself. When this principle is adopted, the control of the water is divided precisely like the land, among a multitude of proprietors. Reservoirs and canals are then like the streets of the town, serving a public purpose and permitting ready access to private property on every hand. Water monopoly is impossible under this method, and no other abuse is encouraged by it. Years of painful experience have abundantly proven that peaceful and orderly development can not be realized except as water and land are forever united in one ownership and canals treated merely as public or semipublic utilities rather than as a means of fastening a monopoly upon the community. In Wyoming and Nebraska the true principle has already been adopted by the State boards of control and put into practice with the best results. If it can be maintained and speedily extended to the other States, as it surely must be in time, it would mark an economic reform of the highest significance in the life of the West.

APPROPRIATION AND DISTRIBUTION OF THE WATER SUPPLY.

Next in importance to the correct solution of the question of water ownership are the great problems of appropriation and of distribution. As soon as possible all ditches used in irrigation should be carefully measured by some public authority and the results of this measurement be given the widest publicity, in order that irrigators may know approximately how much is taken and how much remains to be taken by new canals. The need of this information is so obvious that it will perhaps be difficult for readers unfamiliar with the subject to credit the assertion that in all but four of the Western States the matter has been wholly neglected. This fact is largely responsible for the disheartening litigation which prevails so widely.

It is of almost equal importance to have a scientific determination of the practical duty of water, showing the amount required for different soils and crops. Still further, there must be some form of public control in the distribution of water. Trouble always results when this is left to rival users to determine how much they need, especially in years of partial drought, when the supply may be insufficient for all, and it is consequently necessary to recognize appropriations in the order of their priority.

(Check gates on main canal and a measuring weir are shown in Pl. LVIII.)

PUBLIC SUPERVISION AND CONTROL OF IRRIGATION.

The entire discussion leads up to one inevitable conclusion: This is that irrigation, over and above all other industries, is a matter demanding public supervision and control. Every drop of water entering the head gate, and every drop escaping at the end of the canal, is a matter of public concern. The public must determine, through constitutions and statutes, the nature of water ownership. The public must establish means for the measurement of streams and for ascertaining how much water may be taken for each acre of land under the principle of beneficial use. The public must see that justice is done in the distribution of water among those who have properly established their rightful claims to it. We have thoroughly tried the method of

FIG. 1.—A CHECK AND LATERAL GATE ON MAIN CANAL.

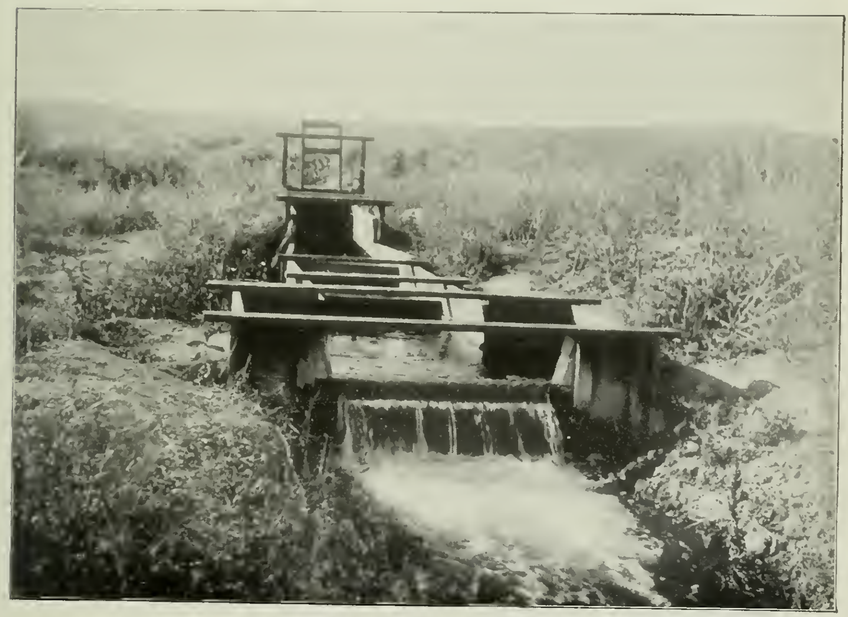

FIG. 2.—A CIPPOLETTI MEASURING WEIR.

leaving all this to private initiative and management, and, along with magnificent material progress, we have reaped a large crop of deplorable financial results.

While much must be left to the action of States and communities, there is still a wide field for national effort. Only the nation can legislate as to the public lands and reform the abuses which have been referred to in connection with the present system of land laws. There is a strong popular demand in the West for legislation providing public aid in the construction of works of too great magnitude and cost for private enterprise and a growing belief that one of two things should be done: Either the arid States should be placed in a position to extend this aid, or the General Government should extend the work it is now doing in the reclamation of certain Indian reservations to the reclamation of the unoccupied public lands. One policy much discussed and widely favored is legislation which will permit of the leasing of the public grazing lands for a term of years at a small annual rental, the proceeds to be given to the several arid States and applied by them to irrigation development. If this is carried out, the settlers owning the contiguous irrigated land should be favored; the object being to unite with the lands reclaimed a certain portion of the public pasture.

The National Government alone can make the best and broadest study of the various economic questions related to the development of agriculture on arid lands. This includes not only the measurement of streams and survey of reservoir sites, but also a consideration of practical methods of applying water to the soil and of social and industrial institutions adapted to the environment of the arid region. The nation alone can deal with the conflicting rights in interstate and international streams and with the construction of great reservoirs at their head waters, with a view to benefiting the several States lying along their course. The National Government is already active along all these lines, and the field for the expansion of its efforts is wide and inviting.

INFLUENCE OF IRRIGATION UPON PEOPLE AND COUNTRY.

While a description of existing conditions in the far West necessarily includes references to many evils and disappointments, there is a brighter side to the picture, and the future is luminous with new hopes for humanity. A vast population will make its homes in valleys now vacant and voiceless, yet potentially the best part of our national heritage. They will create institutions which will realize higher ideals of society than the world has yet seen. Irrigation is much more than an affair of ditches and acres. It not only makes civilization possible where men could not live without it, but it shapes that civilization after its own peculiar design. Its underlying influence is that which makes for democracy and individual independence.

IRRIGATION PRODUCTIVE OF SMALL PROPRIETORS.

Where land can only be cultivated by means of the artificial application of water, and where that water is not under speculative control, it is owned in small holdings. This is so because irrigation intensifies the product of the land and so demands much labor. It is a kind of labor which can not profitably be left to hired hands. The result is a multitude of small proprietors working for themselves. This fact is strikingly illustrated in southern California. Here the farms are small and almost exclusively occupied by their owners. But the great wheat ranches in other parts of the State, notably in the Sacramento Valley, depend chiefly upon hired laborers, who make no homes of their own. The Sacramento Valley has less population now than it had twenty-five years ago. Of the increase of the rural population of the State between 1880 and 1890, 77 per cent went to the irrigated counties, and largely consisted of families who bought small farms and proceeded to do their own work. The influence of a great mass of small proprietors tilling their own land can not fail to have a very marked effect upon the character of the institutions.

DIVERSIFIED FARMING A FEATURE OF IRRIGATION.

Irrigation lends itself naturally to diversified farming and tends to make population self-sufficient within itself. Although in certain localities, especially those where the climate is favorable to raisins and oranges, the contrary has sometimes been true, the tendency of irrigation as a whole has been to discourage the production of single crops and make families independent by producing the variety of things they consume. This tendency is steadily gaining ground. The diversified farming which irrigation both permits and encourages will be an important element in contributing to the independence of the people who shall inhabit the arid region of the future.

IRRIGATION AS A TRAINING IN SELF-GOVERNMENT.

Another interesting feature of irrigation is the training it gives in self-government. A farmer under irrigation can not remain ignorant and indifferent of public questions. He has to consider his interest in the river which feeds his canal and the nature of his relation to other users along its course. It is a training school in self-government and gives the first impetus to civilization in rainless regions. The capacity of the American farmer has already been demonstrated. He is the author of the best of our irrigation laws. Colorado was the first State to enact a law providing for the public control of streams and some sort of systematic procedure for the establishment of rights, but the credit of that is not due to her statesmen, but to the discussions of the Greeley Lyceum and the public spirit and independence of the irrigators under the Colony Canal. Opposed by the conservatism of the legal profession and the prejudices of those not practically familiar with the subject, they had a long and doubtful struggle to secure the adoption of a statute which for a time made the State the lawgiver of the arid region.

In Utah the practices of water users are a hundred years in advance of the State laws. This is due to the fact that irrigators recognize insensibly the community nature of their interest in the streams. The old feudal idea of private ownership in water has never made an irrigated district prosperous, and it never will.

IRRIGATION AND COOPERATION.

Another feature is the tendency toward cooperation. Under the Wyoming law accepting the Carey grant this cooperation is made obligatory. Every settler under a canal becomes a shareholder therein. Not only does the right to water attach to the land, but a share in the canal sufficient to carry the water also goes with it. In fact, the need of watering many farms from a common source and of organizing a community under rules and discipline for the distribution of the supply make a nursery of cooperation. Its most conspicuous manifestation is in the widespread and successful fruit exchanges of California. There are many instances of smaller and more local organizations of a cooperative industrial character, and they are multiplying rapidly. They seem likely to deal with yet larger affairs in the future as communities gain in age, numbers, and wealth.

EFFECT OF IRRIGATION ON SOCIAL LIFE.

Heretofore one of the evils of the irrigated home has been its isolation. The valleys of many streams are narrow. The broad areas which lie between these valleys are the home of cattle and sheep, but not of men. The Anglo-Saxon thirst for land, and the opportunity which the desert-land act gave to gratify it, resulted at first in a wide separation between homes, and in a loss to the pioneer of the advantages of schools, churches, and social life. Under the larger and later canals the tendency has been in the other direction. The European custom of making homes in village centers has been adopted in parts of Utah, Wyoming, Idaho, and California, and steadily gains in public favor. Where farmers live in villages, their families enjoy ready access to schools, churches, libraries, and entertainments. The agricultural society of the future in the Western valleys will realize a happy combination of town and country life—the independence which springs from the proprietorship of the soil and the satisfaction of the social instinct which comes only with community association. Such conditions are favorable to the growth of the best forms of civilization and the noblest institutions. This is the hope which lies fallow in the arid valleys of the West. Its realization is well worth the struggle which is impending for the reform of our land and water laws, and which will impose high demands upon our statesmanship and call for the exercise of the best order of patriotism.

THE COMMERCIAL IMPORTANCE OF IRRIGATION.

The commercial importance of the development of irrigation resources is being realized in the West at the present time as never before. Especially in California there is a new awakening, and an effort on the part of the best elements of citizenship to remove the obstacles which have formerly hampered both public and private enterprise. The East, as a whole, is beginning to realize the great part which the West is to have in the events of the twentieth century. World-wide forces are working to hasten the day of its complete development and of the utilization of all its rich resources. The Orient is awake and offering its markets to the trade of the Pacific coast. With the development of this trade there will come an impulse for the completion of the material conquest of arid America by the enlistment of public as well as private means in the storage and diversion of its streams for the irrigation of its hundred million acres of irrigable soil; the harnessing of its water powers to mill and factory wheels; the crowding of its pastures with new millions of live stock; the opening up of its mines and quarries; the conversion of its forests into human habitations; the coming of a vast population, and the growth of institutions worthy of the time and the place.

SUCCULENT FORAGE FOR THE FARM AND DAIRY.

By Thomas A. Williams,
Assistant Agrostologist.

EARLY FORAGE CONDITIONS.

In the early years of the settlement of this country the farmers found no difficulty in securing plenty of forage from the native grasses for the few live stock they possessed. The supply was abundant for their every need (in fact, seemed unlimited), and little thought was given to the cultivation of crops designed especially for forage purposes. If anything was needed in addition to the native grasses, the lack was more than supplied by the waste or roughage from the various garden and field crops, such as beans, peas, turnips, and cabbage.

As the country became more thickly populated, and a greater proportion of the land was brought under cultivation, the native forage supply was reduced. Furthermore, with the advance of agricultural industries came better methods of caring for stock, and gradually it became necessary to devote some of the cultivated land to the production of forage crops. At first these crops were grown for pasturage or for hay, but with the development of the dairying industry came the demand for succulent feed to keep up the flow of milk in cows during the season of drought in summer and autumn, when pasturage became reduced, and during the winter, when the fresh pasturage was cut off entirely. The supplying of succulent feed for these two seasons presented very different problems.

On the one hand, it was necessary to provide crops on the approach of the droughty season and to arrange for a succession of these while it lasted, the feeding being done from the field or by pasturing off directly; on the other hand, it was not only necessary to grow and harvest the supply of forage for winter, but it must be preserved in such a manner as to be ready for use at the proper time. In the South the problem was less difficult than in the North, since, owing to the climatic conditions, it was possible to secure fresh feed for at least a large portion of the late fall and winter by the use of winter rye, oats, and other so-called winter annuals. Naturally, root crops were among the earliest grown for the purpose of supplying succulent feed for the fall and winter, since they were already extensively grown for this purpose in the Old World. Although these crops have received considerable attention from farmers in different parts of the country, and their cultivation for forage has been at times quite general in certain sections, they have never assumed the place in American agriculture that they occupy in England and other parts of Europe, and it is doubtful if they ever will do so. The reason for this may be found in part in the different conditions under which agriculture has developed in this country, but principally in the fact that corn, one of our standard crops, so readily takes the place of root crops in the farm rotations and is adaptable to use in so many ways as a food for stock. Then, too, the advent of the silo gave the American farmer a means of preserving this crop for an indefinite period in a most satisfactory condition for feeding to all kinds of live stock.

PRESENT METHODS OF PRODUCING SUCCULENT FORAGE.

In the United States succulent food is in the main at the present time provided by means of soiling crops, temporary or annual pastures, and silage.

The crops that are most valuable for the production of succulent forage comprise coarse, quick-growing plants that draw their nourishment largely from the atmosphere and produce relatively large amounts of foliage. They are much less exhausting to the soil than grain and other so-called money crops, and include most of the best soil renovators.

THE PLACE OF SUCCULENT FORAGE CROPS ON THE FARM.

Just as it must be generally admitted that a system of diversified farming is preferable for the country at large, so it must be agreed that succulent forage crops may be made to form a very important part in the rotations to be followed in practicing such a system. These crops can usually be grown in such a manner as not only not to interfere in any way with the regular yields of grain or other primary crops, but even to the great advantage of the latter on account of the direct beneficial effect which they may exert on the fertility of the soil. This is especially true of such leguminous crops as vetches, cowpeas, and crimson clover.

A strong point in the favor of growing crops for succulent forage lies in the fact that an increased number of stock may be maintained on a given amount of land and that the dairy products may be very materially augmented, both on account of the possibility of handling relatively larger numbers of milch cows and also of the greater returns that may be secured from each animal. This is of special significance in the older, more thickly settled portions of the country, as is also the fact that the keeping of this increased number of stock insures more manure for the land. This last is in itself an item of great importance in the maintenance of the fertility of the farm, and, taken in connection with the direct beneficial effects upon the soil of many of the crops grown for soiling and ensiling, is a most substantial argument in favor of giving these crops a regular place in plans of crop rotations.

Another point in favor of the growing of these supplementary forage crops is the fact that the general health of farm stock may be kept in better condition, especially in winter, by the judicious use of succulent forage, which serves as an appetizer and promotes the digestion generally.

GROWTH OF THE PRACTICE OF SOILING IN THE UNITED STATES.

In 1821 Thomas Massey, of Delaware, advocated soiling for the dairy, and urged the great value of corn as a forage crop.[1] In the same year a system of soiling was recommended by a prominent agriculturist, with the following crops in the order mentioned: (1) Grass, including clover; (2) oats; (3) indian corn; (4) cabbage, with the addition of turnip tops and trimmings from other root crops.[2] Other writers of this period speak of the value of corn for this purpose, and from the time that the Government first began to issue reports on the various crops grown in this country it has been regarded as the most important fodder crop. The reports for the early forties contain many references to its use for soiling as well as for cured fodder. Soiling seems to have been quite general about this time in the Eastern and Southern States, but in the then Western States of Ohio, Indiana, and Michigan it was said that "the pastures were too extensive for much to be done in soiling," although "corn was regarded as the best crop for this purpose." In Massachusetts and New York, where the dairying industry was largely followed, soiling was quite favorably regarded and its practice urged by the more advanced dairymen. In addition to corn, other crops, such as peas and oats, were grown, especially in Maine, where, according to the reports for the late forties and early fifties, the production of live stock and forage crops were matters of great commercial importance.

There has been but very little complete soiling practiced in the United States. Occasionally, where the acreage of land is limited, as may be the case in the immediate vicinity of the larger cities and towns, it has been found expedient to keep the animals confined in summer as well as winter and to supply green feed in the form of soiling crops. The general practice has been, however, to combine soiling with pasturing, using the former in a supplementary way only, the animals being allowed to run on the pasture a part of the time and receiving in addition a sufficient amount of freshly cut forage to keep them in proper condition.

One objection early urged against soiling was that the animals were not allowed sufficient exercise when complete soiling was practiced

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[1] American Farmer, May 25, 1821.
[2] Ibid., July 20, 1821.

and that their health was injuriously affected to a greater or less extent. On this account the system followed most generally in the United States is to be preferred. Complete soiling has been urged by some on the ground that under partial soiling stock is likely to become restless in the pasture in attempts to get at the soiling crops. This difficulty may be avoided, as a rule, by growing the crops at a distance from the pasture and feeding only in the barn or yard.

TEMPORARY PASTURES.

Too little place is given to temporary pastures on the average American farm, but one effect of the recent periods of drought has been to turn attention more strongly to this method of producing forage. Often it is much more profitable to furnish stock with succulent food in this way than by soiling, the extra labor and expense of cutting the crop and hauling or carrying it to the feeding place being saved. It is not always possible to keep sufficient help on the farm to attend to the work of soiling properly, but by the use of the temporary or annual pasture the stock may be supplied with the desired feed and the permanent pastures brought safely through a droughty season, because of the lessened drain on their resources. True, this may not be the most economical manner of feeding succulent forage, owing to the waste from the trampling of the animals, but it is much better than keeping the stock on overgrazed pastures, both as regards the condition of the animals and the future productiveness of the pastures.

In certain parts of the country, notably in the Middle West and some sections of the South, this practice of sowing supplementary pastures has become much more common than formerly, partly because of the effect of drought on the yields of forage from the permanent meadows and pastures and partly through the increased demand for succulent feed arising from the growing interest in dairying and the increase of stock on farms heretofore largely devoted to the raising of cotton and grain.

In the main, the crops that are grown for soiling can be also used in these supplementary pastures, but there are certain varieties which are best adapted for this purpose. Among such may be mentioned rye, turf oats, sorghum, rape, vetches, field peas, millet, beggar weed, and bur clover.

HISTORY OF THE PRACTICE OF ENSILAGE.

PIONEER ATTEMPTS AT PRESERVING FORAGE IN SILOS.

The first recorded American silo for the storage of fodder was built in 1875 by Dr. Manly Miles, who says he was led to make the experiment through the favorable reports made by farmers practicing this method of preserving corn and other forage crops in France. He used four small silos, two of which were filled with corn and two with the heads of broom corn. The results were most satisfactory, and Dr. Miles published an account of his experiments the following year.[1]

In 1876 attempts at preserving forage in silos were made by Messrs. Francis Morris, of Maryland, and C. W. Mills, of New Jersey. The results of Mr. Morris's trial were published the following year, and those of Mr. Mills in the Journal of the American Agricultural Association for 1881. Others followed in the footsteps of these pioneers, some with success and others with failure, and the subject was much discussed in the various farm journals. Occasional notices regarding this method of preserving forage had appeared in American journals as early as 1873, but all related to European practices. A great deal was added to the interest exhibited by American farmers through the translation of a French book on the subject, in which M. August Goffart described the method of ensilage followed by himself and others in France. It is interesting to note that while the work of M. Goffart undoubtedly had much to do with the spread of this practice in the United States, it was a German, Herr Adolph Reihlen, who first demonstrated the great value of corn as an ensilage crop. His experiments were carried on in the early sixties, and as a result the ensilage of corn was soon practiced in both Germany and France.

One of the most effective agents in advancing the claims of the silo was the ensilage congress first held in New York City in 1882, in which two days were devoted to the discussion of this method of preserving forage. The consensus of opinion at that time was expressed in the resolution, unanimously adopted by the congress, "that it has become a well-established fact by six years' successful use in this country, and by the concurrent testimony of many intelligent farmers, that the ensilage system is of great advantage to the farming interest and to all mankind."

The progress of this system of preserving forage was no doubt much hindered by the extravagant statements made by some of its early advocates. Practical farmers hesitated to adopt it because of the visionary character of these claims. However, the advocacy of Dr. Miles, Governors Price and Smith, and Messrs. Morris, Mills, Sprague, Brown, and other men prominent as scientific and practical farmers was proof conclusive that there were advantages to be gained by the ensilage of certain forage crops. Here and there enterprising farmers and dairymen began to build silos, and gradually the practice was accorded a permanent place in American agriculture. Seven years after Dr. Miles made his first experiments a report was published by the Commissioner of Agriculture giving the results of the experience of ninety-one farmers and stockmen in different sections of the country, and while these included by no means all the silos that were built at that

[1] Country Gentleman, October 6, 1876.

time, the report is undoubtedly fairly representative of the practice of ensilage throughout the country as a whole. More than half the reports came from Massachusetts and New York, and only a dozen from the States west of New York and south of New Jersey. Some idea of the rapid development of the use of the silo may be gained from the fact that in the report of 1882 but three were recorded from Wisconsin, while in 1896, according to Mr. C. P. Goodrich,[1] "in the town of Lake Mills, Jefferson County, Wis., which contains but thirty-four sections of land, there are not far from seventy silos, and the use of not one of them has been discontinued, but more are going up." It is noticeable that from the first the silo has been most generally used in sections where the dairying industry is paramount.

CONSTRUCTION OF SILOS AND TREATMENT OF CONTENTS.

It is interesting to note that in the United States the development, both as to the construction of the silo and the treatment of the contents, has been along lines of greater simplicity. The expensive structures of masonry, built by most of the earlier advocates of this method and patterned after the silos of M. Goffart and other European farmers, have given place to those of wood, which are at once cheaper and more easily built, while wooden walls are less conductive of heat and cold.

The early practice of placing heavy weights on the material in the silo in order to press it down and exclude the air, and which was thought to be very necessary to the preservation of the forage, was pretty generally abandoned some years ago, as it was found that the forage kept quite as well without such pressure. It was also thought to be of the greatest importance that the filling of the silo should be rapidly done. Dr. Miles was the first to combat this idea, arguing that "with slow filling, without treading down the fodder, the temperature of the mass would rise to a point that is fatal to the bacteria that cause acid fermentation and that sweet ensilage" would result. This view was soon found to be upheld by experiment, and for ten years or more it has been generally accepted that rapid filling is unnecessary, many farmers maintaining that the best quality of sweet ensilage is made by slow filling. Another early idea was that the fodder should be firmly packed as it was put into the silo, but it has been found by experience that all that is really necessary is to keep the surface leveled off and perhaps to tramp the fodder down a little along the edges near the walls of the silo.

In order that the temperature of the whole mass may be kept as uniform as possible, it is a common practice to delay the leveling off of the fodder put in one day until the temperature has risen to the proper degree when the hot material is leveled off, being well packed

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[1] Report Kansas State Board of Agriculture, third quarter, 1896, p. 116.

FIG. 1.—A ROUND SILO ATTACHED TO DAIRY BARN ON FARM OF SOUTH DAKOTA AGRICULTURAL COLLEGE, SHOWING METHOD OF FILLING.

FIG. 2.—AMERICA'S BEST FODDER CROP (FIELD OF CORN GROWN NEAR WASHINGTON, D. C.).

at the edges, and fresh fodder is added at once. This maintains a higher temperature in the outer portions of the mass and results in silage of a more uniform quality. The former practice was to cover the fodder with planks or boards, which were deemed necessary to keep the silage from spoiling at the top. This covering of boards was discarded, however, soon after it was learned that heavy weighting was unnecessary, and a covering of straw, chaff, grass, or uncut corn-stalks was substituted. Nowadays the covering is often omitted entirely, but it is generally considered the best practice to cover with straw, chaff, or grass, since a few inches on top will mold and spoil anyway, forming a practically air-tight covering, and the addition of the straw or other material saves this loss in silage.

At first silos were either square or rectangular, but more or less difficulty was experienced from the spoiling of the silage at the corners, and it was also difficult to make the high wooden silo strong enough to resist the lateral pressure of the mass of silage. This led to the building of the circular silo (Pl. LIX, fig. 1), which form is generally preferred at the present time. There are no corners in such a silo, and a much stronger structure can be made with less building material than in the square or rectangular type. Moreover, the capacity of the round silo is greater in proportion to the wall space. It is the present practice when building a square or rectangular silo to board up or otherwise cut off the corners, thus lessening the danger of loss of silage. Metal linings for the inside of wooden silos have been tried, but with poor success, usually proving less durable than wood. Recently steel siding has been used in place of wood for the outer part of the wall of the silo, and it is said to compare favorably with lumber as to cost.

The first silos built in the United States were "pit silos," and these are still sometimes made, but aside from their cheapness they have no advantage of consequence over those built on top of the ground. A serious objection to them lies in the difficulty in feeding the silage from them. On side-hill situations they can sometimes be used advantageously. It is often possible to build the silo partly below and partly above ground, materially lessening the cost, but retaining the advantages of the above-ground silo.

The desirability of silage as a food for farm animals during the winter and also in times of drought has led to many attempts to construct cheap silos, especially in sections where building materials are high. One of the most satisfactory of these cheap structures is known as the "stave silo." It is built much as a round tank, but is without top or bottom other than the soil, and is composed of 2-inch lumber of varying width held together by hoops of one-half inch iron, with suitable blocks for tightening. When filled a temporary roof may be placed on the silo, or straw or grass may be spread over the silage.

A still simpler and more inexpensive method of preserving fodder fresh from the field is practiced in some sections, notably in Texas and elsewhere in the Southwest. This is by means of the "stack silo." The freshly cut forage (sorghum is usually used) is drawn into compactly built stacks, generally topped with grass, and carefully raked down and heavily weighted. The forage undergoes fermentation and is said to be of good quality, while the loss from molding is seldom very great, being confined to the surface.

VALUE OF ENSILAGE AS A FOOD FOR STOCK.

The value of silage as a food for all kinds of farm stock is now pretty generally recognized. It is seldom fed entirely alone, but usually in connection with a small amount of hay and grain. In the case of horses, it is generally conceded that silage should form but a part of the ration, especially when the animals are doing hard work. On dairy farms silage holds a particularly important place, but even here it has had to win its way against strong opposition. Although it was early admitted that this forage when properly fed materially increased the flow of milk and exerted a beneficial influence on the health of dairy cattle, many dairymen refrained from using it because it was said to taint the milk and butter. This has been shown to be largely erroneous, at least so far as silage of good quality is concerned, and in any event may be avoided by feeding the cows only after milking. It has been shown by experience that the cost of milk and butter can be materially reduced by the judicious use of good silage.

In summing up the advantages of silage under the system of agriculture prevailing throughout the greater part of the United States at the present time, it may be confidently maintained that with no other method can so much forage that is so palatable and of such feeding value be secured, be so safely harvested, stored so economically, and fed with so little waste. The silo is certainly a most valuable adjunct of intensive farming, may almost be regarded as a necessity on any well-ordered stock or dairy farm, is a safeguard in times of drought as well as in excessively wet seasons; its use is by no means necessarily confined to the wealthier farmers, but is spreading rapidly in all sections of the country where the acreage of land is limited or where succulent forage is needed during the winter months.

THE BEST CROPS FOR SUCCULENT FORAGE.

CORN.

Corn (Pl. LIX, fig. 2), the most valuable crop of our forefathers, early assumed an important place as a forage crop, not without some opposition, however, for it is said that the idea of sowing it for fodder was at first ridiculed.[1] As early as the second decade of the century

[1] Flint: Grasses and Forage Crops, p. 154, fifth edition.

this crop is mentioned as a most valuable one for soiling, and from the first introduction of the practice it has been regarded as the best to grow for this purpose.

It was early observed that certain varieties of corn were more adapted to use for soiling and fodder than others. These have been improved and increased by selection and crossing until at the present time there is a long list of varieties, some of which are suitable for soiling and ensiling in any part of the United States.

Two points have been kept in mind by those endeavoring to develop the varieties of fodder corn, namely, the desirability of varieties with a long season of utility and producing heavy yields of foliage rather than of grain. Thus, we have the various "evergreen" varieties, which remain in condition suitable for feeding for a relatively long period, and other varieties, which give exceptionally large amounts of forage. These last are especially valuable for ensilage. By the use of a judicious selection of early and late varieties, and planting at proper seasons, it is now possible to have plenty of green corn for soiling for a large part of the summer and autumn in most parts of the United States.

CLOVER AND OTHER LEGUMES.

As the need of succulent forage became more generally recognized, it was found desirable to grow several crops for use each season in order that a succession of fresh forage would be assured. It was also found that a better quality of forage might be secured by selecting a suitable variety of crops to be grown in this way. Among the more important crops used for this purpose, in addition to corn in the early part of the century, were field peas, usually grown with oats or other small grain, clover, cowpeas, rye; and, a little later, millet, sorghum and other crops came into use.

CLOVER.—Red clover was grown in Rhode Island as early as 1750. John Bartram is said to have grown it on his place near Philadelphia, Pa., prior to Revolutionary times, and, according to Darlington, it was introduced into general cultivation in Chester County, Pa., during the last decade of the eighteenth century. Suffolk County, N. Y., was an early center for the cultivation of this crop, and considerable seed is said to have been exported from there. Red clover was included in nearly all lists of crops desirable for meadows, and its use for soiling seems to have been quite general in the North during the early part of the present century. It did not win its way unchallenged, however. A writer from Indiana, in the United States Patent Office Report for 1849, speaks of the strong prejudice against clover prevailing in his section on account of frequent deaths among cattle when first turned on it, and because worms destroyed corn following the clover. Its value as a soiling crop was early recognized, however, and it is still to be regarded as one of the best perennial crops available for this purpose, as well as for use in the silo.

Mammoth, or sapling, clover is frequently grown and used in the same way as red clover, and in some sections, especially where the soil is wet and heavy, alsike replaces both of these.

COWPEA.—In the South the cowpea early assumed the place occupied by clover in the North. A writer in 1821 recommended the cultivation of this crop for forage and soil renovation,[1] and there are references to its use for these purposes at least as early as 1815. Many writers for the United States Patent Office reports and farm journals during the second quarter of the century speak of the great value of the cowpea (several varieties of which were grown chiefly under the name of black-eyed peas) in the South. A writer from Louisiana says, in the United States Patent Office Report for 1849, that the cowpea ranks next to corn in importance to the sugar planter, both for its value for forage and as a soil renovator, while another from Tennessee calls it "perhaps the most valuable crop in the South." Although it was more often made into hay or the crop fed off on the ground, it was also often used for soiling, and in recent years is frequently made into silage, being generally regarded as next in value to corn and sorghum for this purpose in the South. It is used to best advantage in connection with corn as a mixed silage. During recent years many new varieties of cowpeas have been developed, some of them, because of their season of maturity and upright habit of growth, admirably adapted for soiling and ensilage.

FIELD PEA.—One of the first leguminous crops to be grown in the United States for succulent forage was the field pea. For many years the cultivation of this crop was confined largely to the New England States, but of recent years it has received more attention and is now quite generally grown in the Northern United States, where it is deservedly popular not only as a succulent forage but also as a hay crop. There are a great many varieties now on the market, varying widely as to hardiness, date of maturity, and yield. The seed is usually sown with some of the small grains, chiefly oats, the mixture containing about equal quantities of peas and grain. The crop is, perhaps, most commonly used for soiling, but is equally valuable for pasturage and silage. The combination makes a forage of high feeding value and palatability, and the yield is usually good.

ALFALFA.—Another legume of great importance as a soiling crop is alfalfa, or lucerne. A writer in 1821 regards it as a most valuable crop for South Carolina, and claims to have grown it for seven years, with the best of results, securing from six to eight cuttings per year.[1] A New Jersey farmer, writing a few years later (1823), says: "Of all grasses, it is the most profitable for soiling;" and Judge L. Buel, of Albany, N. Y., an authority on such matters, also speaks highly of it

[1] American Farmer, 1821.

for this purpose. In fact, in the earlier years of its cultivation in the United States it seems to have been grown almost exclusively for soiling. The seed was brought from France, and the French name "lucerne" was generally used. It was much less widely grown than red clover, however, until after the introduction, in the early fifties, of the Chilian variety, on the Pacific coast, from whence its cultivation has spread over the whole United States. Although largely grown as a hay crop at the present time, it is also much used for soiling. The early season at which it is ready for use in the spring, the fact that several cuttings may be made each year, and the high feeding value of the forage make it a very desirable crop to grow for this purpose. The recent introduction of the hardy Turkestan alfalfa by the Department of Agriculture promises to make this desirable forage crop available to sections where it could not be grown heretofore on account of unfavorable climatic conditions.

SOY BEAN.—The soy bean was introduced from Japan in the early part of the century, but was grown in a desultory way for a long time, only coming into prominence as a forage crop within comparatively recent years. It was apparently first grown in the botanic garden at Cambridge, Mass. In 1829 Thomas Nuttall[1] wrote regarding its possible value for cultivation in the United States, and another writer tells of its having been grown at Cambridge in 1829 and at Milton, Mass., two years later.[2] It is now regarded as one of the most valuable crops for soiling and ensilage. Careful selection on the part of those engaged in growing seed for the market has resulted in the development of early, medium, and late varieties, so that it is now possible to get a good supply of fresh soy-bean forage for a large part of the summer and autumn. Although probably less valuable in the South than the cowpea, it has a more extended northern range, and hence serves as an intermediate between that crop and clover.

VETCHES.—Of the vetches, common and sand (or hairy vetch) are the only sorts that have been grown to any extent in this country, and these, while grown and used in essentially the same way, have been by no means as commonly cultivated as field peas. Common vetch seems to have been first introduced, and both spring and winter varieties were grown as early as 1820, principally under the name of tares. Several writers in the farm journals published in the early twenties speak of their value for soiling and supplementary pasturage, and in some sections large fields were devoted to the cultivation of these legumes. One farmer speaks of growing 30 acres of tares annually. Sand, or hairy vetch, is of much more recent introduction, and is, if anything, better adapted to general culture throughout the United States than the common vetch.

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[1] New England Farmer, October 22, 1829.

[2] Farmers' Cabinet, October 15, 1847.

Crimson clover.—Crimson clover is one of the most valuable legumes grown in the Middle Atlantic States. It was introduced from Italy in 1818 by Bedingfield Hands, of Chestertown, Md., and first grown by him and others to whom he gave seeds. In the first notes regarding it that appeared in the agricultural journals it is called Italian clover, but this name was soon supplanted by the one now in most common use. In 1820 Mr. Hands gave an account of the introduction of this clover and his experiments with it,[1] and still earlier a Dr. Anderson, to whom Mr. Hands had given seeds, recorded the results of his trials, speaking enthusiastically regarding the value of the crop, particularly for green forage. Aside from being one of the most valuable cover crops and soil fertilizers grown in the Eastern United States to-day, crimson clover ranks high as a forage crop, especially where the climatic conditions are such that it can be sown in the autumn for an early crop the next season. Affording an excellent hay when cut in the right season and properly cured, it is also extensively used in soiling and for filling the silo, as well as in annual pastures.

Japan clover.—Japan clover was an accidental introduction from Japan, as it name indicates, first coming into notice in this country about 1830. It now occurs quite abundantly in the naturalized state throughout the greater part of the region south of the Ohio River. It is, perhaps, most valuable as an annual pasture crop, but is also used in other ways. Its ability to endure heat and drought and to thrive on a great variety of soils renders it of much importance as a forage as well as a soil renovator. It is available as a pasture plant from May until heavy frost.

Florida beggar weed.—Florida beggar weed has only recently become of importance as a cultivated crop. It is a native of the West Indies and quite likely, also, of southern Florida, where it was first cultivated. The plant is an annual and is well adapted to the light, sandy soils of portions of the South. Its cultivation is spreading rapidly, and although it has thus far been most commonly grown for hay, it is also valuable for soiling, pasturage, and ensilage.

Velvet bean.—Another succulent forage crop which has recently attracted much attention is velvet bean. Its first introduction into the United States seems to have been through the Department of Agriculture some thirty years ago. Until within a few years it was grown solely as an ornamental plant, but proving adapted to the light, sandy soils of the South, it was taken up as a soil renovator and forage crop, and is now being grown and used in essentially the same ways as the cowpea.

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[1] American Farmer, May 19, 1820.

FIG. 1.—JAPANESE BARNYARD MILLET, GROWN AT THE UNITED STATES GRASS EXPERIMENT STATION, WALLA WALLA, WASH.

FIG. 2 —KAFIR CORN, GROWN IN SOUTH DAKOTA.

MILLETS.

Millet was recommended for soiling by various writers in the early twenties, and its use for this purpose was urged in the United States Patent Office Report for 1847. Varieties of both foxtail and broom-corn millets seem to have been included in these early discussions, although it is difficult, often impossible, to tell just what kind of millet the writer had in mind. At one time Hungarian millet attracted some attention, but it soon gave way to common millet and German millet. During recent years several varieties of broom-corn millet have come into prominence, notably certain sorts introduced from Japan and Russia. Another millet which has been highly recommended by prominent agriculturists is Japanese barnyard millet (Pl. LX, fig. 1), a recent introduction from Japan. Pearl millet can also be used to advantage as a soiling crop, and is perhaps more valuable for this purpose than for any other.

SORGHUMS.

In some parts of the United States, especially in the South, sorghum has, since its first introduction, been regarded as a valuable soiling crop. Under the name of Guinea corn its cultivation for this purpose was urged by John Lorain in the Memoirs of the Philadelphia Agricultural Society as early as 1810, and frequent references to it occur in farm journals during the succeeding decades. A writer in 1822 speaks of the great value of "Guinea corn"[1] in South Carolina, and its use as a forage seems to have early become quite general in the South. Fresh impetus was given to the growing of sorghum by the importation of new and valuable varieties (especially of the saccharine sorghums) from South Africa, China, and other countries, during the early fifties. The value of the saccharine varieties for soiling was soon recognized, particularly in the South, and this use of them has spread until it is now quite general wherever soiling is practiced to any extent. The more recently introduced Kafir corn (Pl. LX, fig. 2) and Jerusalem corn, nonsaccharine varieties, are also much used in Kansas and neighboring States, and the growing of these crops is spreading rapidly, particularly in sections where the dry weather is liable to interfere with the raising of indian corn. The sorghums are valuable to grow for ensilage, but are not generally regarded as equal to corn for this purpose. They may also be used to advantage in temporary pastures.

OTHER CROPS FOR SOILING, PASTURAGE, OR SILAGE.

Many other crops are available either for soiling, pasturage, or silage, but their use has not become general, and in many cases their value is only local on account of their cultivation being limited by

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[1] American Farmer.

soil or climatic conditions. Among such crops may be mentioned rescue grass, more or less extensively grown in the South for winter pasturage; rape, quite widely grown in the Northwest in recent years for soiling and pasturage; bur clover, a valuable annual pasture crop for the South and Southwest; Guinea grass, grown in the extreme South and regarded as valuable for soiling; sweet clover, grown to some extent in the South and West, for soiling and silage; Australian saltbush, valuable for soiling and pasturage, particularly on alkali soils in the Southwest.

WORK OF THE BREEDER IN IMPROVING LIVE STOCK.

By John Clay, Jr.,
Chicago, Ill.

INTRODUCTION.

The work of the breeder in improving cattle, sheep, and hogs is a subject that can be best considered in detail. Looking back, one sees a wide trail, with numerous bypaths deviating from the main track; and then looking forward, one sees the fields that are yet unbroken, and wonders where will the end be. The work assigned to the writer is to endeavor to trace and comment on the work of the improving breeders, the men who by choice or by chance have made our cattle, sheep, and hogs such as they are to-day.

EXTENSION OF THE CATTLE INDUSTRY.

Behind us lies the New England shore, beautiful as to scenery, but with rocky hills and narrow glades sparsely grassed. Southward is New York State, with widening valleys and deeper soil, while still farther south lie Pennsylvania and the Virginias—all the home of scrub cattle for many generations. In these sections and in Texas and in the California valleys was the mother lode of the present cattle business, and following it came sheep and hogs. But it was not until the arrival of the era when our agriculture crossed from the original States of the Union to the great valleys of Ohio, Indiana, and Kentucky that the searchlight of improvement was flashed upon the live-stock industry, which has been developing new fields year by year. When the industry reached the prairie a plain of unrivaled richness was exposed. As blue grass supplanted blue stem, and golden corn supplied winter food and gave fattening power, then the breeder felt the pulsation of the coming strife. Look over this land to-day. Illinois, the great central State of the West, produces a perfect hog, with sheep still waiting for the improver's hand, and cattle rapidly climbing the golden stairs of perfection—by no means at the top as yet, but with aspirations to be there by and by. The great wave of improvement which began in the thirties and covered pretty thoroughly the Central West, was arrested with the war, but swept on again with widening scope when hostilities had ceased. Down in Texas, the "Longhorns" had accumulated, and there was a market North, but the quality of the stock was undesirable. Westward, under the shadows of the Rockies, scarcely bigger than a man's hand, was a bovine cloud silver lined. During war times Iliff was in Colorado, Kohrs had tested Montana.

There was a glamor in free grass, and, at a time when our beef and mutton supply needed great extension, the ranchman sprang up with his herds and flocks on every creek. His advent had a vast influence and gave a great stimulus to the breeding of fine stock. The cattle man wanted bulls and the sheep man wanted rams, by the wholesale. True it is, that the demand was erratic, but when it came it was a perfect flood. We had it in the early eighties, and now it is with us again. Geographically speaking, the wave of improvement has been westward. To-day it is working strongly in the Southwest and intermountain regions. Texas is drawing heavily on our best cattle blood. The valleys of the Rockies are importing bulls and raising alfalfa, while the Northwestern States are taking both rams and bulls by the car load. But the cattle man is more aggressive in this line than his brother stockman. On the Pacific coast much has been done in the way of improvement, but there progress is often retarded by droughts, distance from market, and low prices. Some of the California herds show wonderful breeding. For many years past, with all the herds in pastures, the opportunities for development have been excellent, and as a consequence the cattle in that State are of high grade, most of them strong in Shorthorn blood, which has been freely imported in years past and industriously nursed and multiplied.

SOME OF THE DIFFICULTIES OF EARLY CATTLE BREEDERS.

The United States and Canada (for the latter is so intimately related to this country in the way of improving live stock that it must be included in the forward movement) are countries of magnificent distances, and while, of course, we have had the railroads, still the foundation of the work of improvement was laid so long before the iron horse came into action that it is almost impossible to estimate the geographical difficulties of our earlier breeders. In England a good day's journey on horseback took Bates or Booth or Bakewell to almost any point he had to reach, but the men of Ohio, when they went forth to search for blue blood, had to cover vast territory, cross great rivers and lofty mountain ranges, and ferry an ocean that knew not the whirr of the screw and was but hearing the echo of the side-wheeler. Only great faith and indomitable perseverance surmounted these geographical obstacles, and the knowledge that the country was far behind the times in meat and milk producing was an incentive to action, for in those men's minds there was undoubtedly a glimmering of the future.

REVIEW OF CONDITIONS.

NEED OF MORE AND BETTER MEAT.

However congenial the work of the breeders may be to them personally, collectively there has been an enormous influence behind them in the incentive for improvement. The cry of the country has been for more meat and better meat. We need more and better hams and bacon; we still lack in both quantity and quality in our mutton, while in beef there seems to be a tremendous pressure for the better qualities. While our cattle statistics may show a decline in numbers of some classes of cattle, still much is made up by the system of early maturity. The two-year-old has taken the place of the three-year-old on the block. To estimate the actual difference in production would be a perpetual-motion problem and one that could only be approximated, but it is patent to everyone that decrease in numbers has been largely offset by forcing methods. We have a fair number of medium cattle. It is the prime bullock that is being called for. The unfortunate lethargy of the ordinary breeder during the decade previous to 1896 in refusing to use better blood is reflected in both cattle and sheep.

CATTLE AND SHEEP INDUSTRIES COMPARED.

After the boom in cattle prices, from 1882 to 1884, we underwent a period of depression that drove the average breeder of fine stock almost out of the market. The depletion of our pure-bred herds was heartbreaking. Once before, during the civil war, we experienced a similar condition, but with good reason. Here we were in the piping times of peace, with the country prosperous, with a spirited demand for our meats, and yet in some years the great bulk of the well-bred bulls had to be steered. In a similar but far less extravagant degree the breeder of fine sheep suffered. The sheep business is always more uncertain than the cattle trade; more subject to sharp fluctuations; more susceptible to political and commercial conditions; it depends upon wool and mutton, the former an uncertain quantity in the world's markets, and a political football. The life of the sheep raiser is a sort of seesaw; now he has the high-growing plum of success and profit within his grasp and now he is down; down on the hard ground of failure and loss. One year he is Sisyphus, striving hard to push his great stone up hill; the next a veritable Jason, who has found the golden fleece. Wool goes up, then follows the sacrifice of mutton. Wool declines, but it is not certain that mutton will improve in quality or price, nor have we had in this branch of the trade that steady foreign demand that has characterized our beef, bacon, and cheese trade. Then there are enigmas in the sheep trade past all understanding, and disheartening to the improving breeder. When a New Mexico lamb, hairy, half goat in form, but with a clean-cut, fine face, that equals the profile of the Cheviot, sells as high as the best Southdown or Shropshire, our ideas of breeding get a shock. But withal there is a tendency to push vigorously the development of our flocks. There is a disposition to follow the middle course, to cultivate wool, but not sacrifice mutton, and vice versa. Unlike the cattle trade, our great source of sheep supply is the open range. Gradually the days of cattle grazing on free grass are being numbered. The lights that were kindled in early days in Texas and burned brightly in Colorado, Wyoming, Montana, and other Western States from 1865 to 1895 are getting dim and will soon be but a reflection in the bovine sky. Against this come increasing flocks on the cattle ranges. We are, so to speak, in a transition state, so far as our flocks are concerned. With low prices for wool, and our sheep unable to compete in a mutton line against our beef and hog products, the small raiser of sheep in such States as Ohio and Indiana was driven out of the field.

On free grass they could be produced cheaply, and the fed Western wether—raised, say, in Wyoming and finished on Nebraska corn—could be placed on the market at a figure far below the cost of the same animal in the granger States. In a milder form we had a similar experience in cattle. When the ranchman found out the value of the grass on the arid regions, and was not overstocked, he raised a steer for a comparative trifle, and the men on the high-priced lands of the Eastern and Central States found a new competitor, who cut into their profits. But that era is coming to a close. The free grazing lands, or, at least, the watered portions, are being preempted in one way and another, so that the cost of producing a steer in the West varies but little from that of growing one in the East, when the cost of transportation to market and other incidentals are considered. The breeding of cattle on free grass is practically a thing of the past. A few large herds remain, but in another decade they will have gone. The free grass of the West will be cropped by cattle that are fed in fields in the winter, by steers imported from other parts of the country, but the lion's share will go to our vast flocks of sheep that have found a natural home in the valleys and divides of the Western and intermountain States. But the day is coming to sheep, as well as to cattle, when free grass will not be enough. As their numbers augment, and they crowd one upon another, cropping the wild grass more closely and killing its productive power, winter feed will have to be supplied, and the cost of production will be materially increased. Then will come with them, as it has with cattle, more attention to breeding.

SECTIONS WHERE GREATEST IMPROVEMENT IS SEEN.

There is no place where demand stimulating supply has had greater effect than among the pasture herds of the West and Texas, especially the latter State at present. If you want a supply of good feeders in large numbers, where do you go? To the Panhandle of Texas, the valleys of Colorado, or the wind-swept divides of Wyoming, and you find there the material that tops the market. Of course, there are solitary lots of native-bred steers that are better, but if any large number of first-class young feeders is needed you must look beyond the Missouri. Why? Because those cattle men neither slumbered nor slept. They were buying blood, and that blood crossed on the already improved Texan or Western cow gave us the steer that fitted the feed lot. When the farmer of the East and Central West could have secured the means in the shape of a good bull at no greater cost than $50, he used a scrub, and the result is seen in our central markets. Native steers have deteriorated, Westerns improved. Not the ranchman who breeds by hundreds has led the van, but it is the small breeder in the valleys or by the streams in the West who has made the most rapid progress. As in cattle, so in sheep. The writer expects to see smaller flocks in the West, more attention to winter feeding, and consequently less loss. Then will come the day when the flocks of the pure-blood breeder will be drawn upon heavily and undoubtedly successfully, although, from the peculiarities of this trade, it is by no means so certain that the results will be as far-reaching in this branch of our live-stock trade as in the beef-making line, and incidentally, of course, in our dairy products.

INFLUENCE OF FOREIGN DEMAND.

Undoubtedly, the foreign demand has been the greatest incentive to improvement. It developed years ago in the inquiry for our hog products, an issue we were able successfully to meet. In our sheep exports we are still away below the European standard. True, we send large numbers of sheep to Great Britain, but they fill a third rate place. Thus far blood has not been used effectively in this line, but it will come. It is with cattle that we are at present reaping the best results of well-sown seed. We go to the parent country; buy in Aberdeen their best Shorthorns and Angus cattle; from Hereford and other parts of England we import the best White-faced blood. Streaming through our native pure-bred herds it reaches in diluted form our feed-yard steers, and then it returns across the ocean, giving that reciprocity of trade which England cultivates so generously.

Twenty-five years ago I rode across an Illinois farm. The original owner had "trekked" from Kentucky. He built wisely and well, and his sons were reaping the benefit. There was blue grass in profusion divided into generous inclosures by osage-orange fences, and the fine buildings were shaded by oaks and black walnuts—a heritage for any prince. On the pastures were 1,000 cattle, not extra in quality, but rough beef. They needed still the varnish that comes from corn. "We want these in England and we must have them," was my remark.

Think of it; a quarter of a century ago we had not, commercially speaking, sent a live bullock across the Atlantic, but since then endless numbers, both dead and alive, have found their way to Europe. The Europeans do not get our best cattle because New York and Boston still claim these, but the exporter buys a grade close to the top. He wants nothing else. This influence on the market has been far-reaching and all-powerful when we come to gauge quality. Our foreign demand is here to stay, and it is a most important factor in our commerce. It can be helped mightily by the breeders of both classes—those who raise the bulls and those who raise the steers. It is a fertile field, boundless in its size, and it is ready to be cultivated. It is a mine from which we can dig more gold than fróm all the real mines put together. It gives labor and means of support to hundreds of thousands of our farmers, and that means happiness, individual and national. One of the wellsprings of our prosperity rises in our export trade, and among its various branches our live-stock products form no mean proportion, for in our annual shipments across the Atlantic we estimate our cattle and sheep in the hundreds of thousands, and our dressed products in millions of pounds. Our live-cattle exports alone last year exceeded in value $30,000,000, while our meats and dairy products had an aggregate value of $180,000,000, a seventh of the total value placed upon our exports of domestic merchandise in the calendar year 1899.

IMPORTATIONS.

THE THREE LEADING BEEF BREEDS.

It will not be a serious digression to give here a bit of historical matter as leading up to present conditions and showing some of the efforts exerted to improve our live-stock blood. The bovine aborigines of this country were of Spanish origin. Early in the seventeenth century Dutch settlers in New York introduced cattle from their mother country. A little later Sweden sent over a consignment to some of her sons and daughters. Several importations from Denmark were made about the same time, and the British Isles furnished their quota also. These cattle were imported for practical purposes (food and work), and the questions of breed or race did not enter very largely into the consideration. From such mixed ancestry our so-called "native" cattle sprang into existence. As immigration increased and as our pioneers forced their way through the "forests primeval" toward the Allegheny, toward the Ohio, and toward the Mississippi, our bovine stocks increased materially in numbers, but became essentially of more and more mixed breeding. Importations were largest from Great Britain, and the predominating strain in the conglomeration was British. Not until the dawn of the nineteenth century, in fact not until the century was sixteen or seventeen years old, were there any notable importations of "improving cattle." The years 1816 and 1817 are notable for the importation of numerous Shorthorns, Hereford, and Devon individuals, Kentucky getting the choicest specimens of the two former breeds. Lewis Sanders and Henry Clay were the first importers of Shorthorns and Herefords, respectively, into the blue-grass regions of that State. It was in 1834 that Shorthorn importations began in right good earnest, with the formation of the Scioto Valley Association in Ohio. Purchases were made almost regardless of prices asked, but the animals and their progeny found ready sale among the then extensive breeders and graziers of Ohio. The Clays and others made important importations into Kentucky in the years 1837, 1838, and 1839. In the last-named year Bates blood found its way from Kirklevington to New York. In 1853, at the Lord Ducie's dispersion sales of Bates and other strains, Americans purchased freely, particularly of Oxfords and Duchesses. Ohio and Kentucky received very notable importations, and in these States were established some of our now most historical herds. American investments in connection with Shorthorns exceeded those in connection with all other breeds combined. Famous in our Hereford history is the importation of 1840, the bulk of which became the property of Mr. Corning, of Albany, N. Y. It was not until many years later, however, that importations were on any large scale. The last few years have seen decreased importations of White-faces as of other breeds, because of the era of comparatively low prices and unprofitable breeding operations through which we have just passed.

The remarkable demand from the range country for Hereford breeding stock has given an immense stimulus to the Hereford industry. Their adaptability to range conditions has established their reputation as "incomparables" in that respect, and the most notable purchases of the past few years have gone to Texas and the northern ranges. Angus cattle came in the seventies, and their preeminence in the feed lot and upon the butcher's block is the result of careful breeding and good management. Their character fits them for the climate of Illinois or Iowa, but they do not, as a rule, possess enough hardiness or "rustling" qualifications to be a success on the open range. This brief résumé of our three leading beef breeds may convey some idea of the efforts put forth to better our bovine stocks. The general effects have already been noted.

SHEEP.

Our earliest ovine stocks were, as with cattle, of Spanish blood. Wool was the primal consideration, and the Merino filled the bill completely. When mutton became more of a factor we got the Southdown and the Shropshire, the Cotswold and the Lincoln, combining both these most important commercial items.

IMPROVEMENT IN BOTH CATTLE AND SHEEP.

In both cattle and sheep we have had the material for foundations secure enough to support any superstructure, but in too many cases we have builded unwisely, or have suffered from adverse causes that could not apparently be combated. To-day, however, we may mark improvement, and two of the strongest reasons for this are the wonderful demand among our ranchmen for good bulls and good rams and the excellent demand from abroad for our products, bovine, ovine, and porcine, reference to which has already been made.

PEDIGREE.

What is pedigree? A mass of hieroglyphics to the ordinary mortal, a sweet morsel for the expert to roll off his tongue when walking through a herd. "Full of Duchess," "full of Anxiety or Wilton," "full of Blackbird blood," is the too often repeated song of the champions of the Shorthorn, Hereford, and Angus breeds. Pedigree, in the language of the poet, is the "claims of long descent." The dictionary adds "lineage," but in the animal world it means the way to uniformity. How long pedigree has been practiced we know not, but undoubtedly it was in vogue long before we heard of it in print. Certain it is that on the borders of England and Scotland, among the Cheviot hills, it was unwittingly resorted to generations ago, but so far as practical and general purposes are concerned its historic exponents were in sheep, Bakewell; in cattle, Bates and Booth. These men built a strong foundation. They grafted stock on hardy roots. Another question often arises in our minds, Would they have followed their system to the disasters that overwhelmed their successors? It is scarcely worth discussing except from the sentimental side. My own idea is that these masters in the art of blending blood would have seen the rocks ahead and veered the ship.

NEW ERA IN BREEDING.

With the use of pedigree in its conservative and carefully considered way we entered a new era in the history of breeding. The soil had long been ready, but the plow and the guiding hand were wanting. They came, they saw, they conquered. In groping about and testing the new fad, as it was called, individual merit was never forgotten. It was the keystone of the arch on which the paper pedigree was built. Bakewell's instinct, Bates's keen scent for the good animal, laid the great fabric of line breeding more strictly than pedigree on a wise and, to them, seemingly impregnable foundation.

The American breeders, casting around for better blood than was at hand, were not slow to recognize and utilize this new invention, if we may so call it. Importations were made, the history of which in detail it is not within our province to recount. Their influence was wonderful, but much of the good blood while coursing through the veins of the common cattle in the districts where good luck had taken it, was lost in hopeless contamination in the backwoods scrub. But much also remained, and was eventually concentrated in Kentucky, the beau ideal spot of the States, so far as the bovine race is concerned. The vicissitudes of the breeder of fine stock were many. Commerce ebbed and flowed; panics came, and war spread over the land, but amid all, pure blood was cared for, nursed, and nurtured.

SPECULATION IN PEDIGREE.

It was not until some years after the war that speculation in pedigree, which had been inoculating the system of the American breeder of Shorthorns for many years, reached flood tide. Its zenith was attained at the New York Mills sale in 1873. Nothing in the history of Shorthorns (and sympathetically in other beef breeds) ever did more harm than the above sale. It is often referred to with pride, but it was the culmination of a vicious system, the exploding of the balloon, whose inflation had been a gaseous mixture of pedigree sans individual merit and "no surrender" of ideas once fixed. By some people this would probably be named fashion. Fashion has its votaries, and it takes a superhuman effort to stem the tide. You went to a sale (and we speak now almost exclusively of Shorthorns, the other beef breeds not appearing at that time in any large number), and what was the result? A good cow, heifer, or bull, excellent in individual merit, and with a stainless pedigree, so far as pure blood went, sold for a song, while some puny, delicate, consumptive-looking beast with a fashionable lineage was bid up to fabulous prices. Then the bubble burst, and into the whirlpool went many a staunch breeder who, carried along with the current, could not escape the vortex. The rebound from such a blow was detrimental to all breeders, but more especially to those in the Shorthorn trade, and from which they have but slowly (though we hope surely) recovered.

The damage done was more indirect than direct. Individual breeders suffered heavily, but nothing in proportion to the raisers of cattle. Pedigreed cattle were at a discount, and there being little or no demand, well-bred calves were made into steers and heifers were sent to the butcher. In my own case, for a half dozen years every male was steered, and that in a region where blood was almost priceless. To-day we are suffering in our markets for this neglect of pedigree. The breeders sowed the wind and the raisers reaped the whirlwind.

ABUSE OF PEDIGREE.

But the abuse of pedigree went further. From line breeding it went on to incestuous breeding. Bates sinned here and intensified the heresy. Hundreds fell into the rut. Then came tuberculosis, or to put it more plainly, consumption. The cry of pure Bates or Booth was a fearful shadow hanging over the premier tribe of cattle. The master hands were gone and their disciples failed to carry on the work. Our American breeders pursued the above course with a determination worthy of a nobler cause. It spread all over, and, though Kentucky probably suffered worst, we saw it in every other State and Canada. Shorthorns have been specially spoken of in this respect, as the writer's acquaintance with them has been most intimate, but we know enough of the dairy breeds, more particularly the Jerseys, to speak of the extraordinary ravages tuberculosis has made in their ranks. To get impressive power that would supply the block or pail, sacrifices were made that eventually led to disaster. Tuberculosis came, and is to-day existent in many of our best herds of cattle, plain or pedigreed. Nature exacts the penalty for reversion or disobedience of her laws. This is the reef our improving breeders must guard against. We see intensity of blood used with grand effect in sheep, among our Lincolns in England, with Border Leicesters in Scotland, and notably with Cheviots in their native hills; but in cattle we have had signal failures in Shorthorns and Jerseys. Let our Hereford and Aberdeen-Angus brethren take warning from the past.

THE BATTLES OF THE BREEDS.

In discussing the work of the breeder and his forward movements we must refer to the so-called "Battles of the breeds." These have been fought over and over again and so repeatedly that the subject is almost threadbare, so far as the press is concerned. But instead of deprecating them, we think they should be encouraged. People will lose their temper both on field and farm, in stall and show yard. The class of personal argument that we have listened to around a show ring, often running into abuse and sometimes growing almost into fisticuffs, should not be encouraged, nor should the jockeying indulged in by the professional showmen be allowed; but the honest, fair discussion of merit, either on paper or by practical illustration, should certainly be given a fair field and no favor. Nothing in our bovine history can equal the struggle made for place and position by our Hereford breeders. Their enterprise, their perseverance, and the magnificence of their methods call forth the highest praise. I would not like to aver that it equals the individual efforts of the early improvers of our cattle in their importation of Shorthorns, but it is so much more recent and the movement so much larger and so intense in its results that the history of sixty years ago is dwarfed in our minds. In the dairy breeds we have had the same experience as with our beef breeds. The Jerseys were boomed, were advertised, were carried up to the zenith of their powers, and then came the natural results of inbreeding and incest. And yet I would be the last to say that great good was not done in these booms of the past or will not be done in further eruptions which the future will produce. The world would be nowhere if we had not the man of progress. You may gallop too fast, but that is certainly better than never to reach your goal. Let us survey the subject a little closer, not so much in a spirit of criticism as to show forth, if possible, in bold relief from the pages of the past some of the mistakes we have made in our live-stock methods of improvement. Sixty or seventy years ago there was no necessity for any argument as to the different breeds of cattle or sheep we imported. Then the only object was to get blue blood. The breeders of the old country had shown the way—had blazed a path through the scrub forest and undergrowth. Every drop of blood was gold to our farmers and stockmen and eventually to our commerce. Nobody can detract from the efforts of our early pioneers who imported Shorthorns, the premier tribe of beef cattle, then and now.

No man loves the Shorthorn more than does the writer. Take them all round, both in the stall and at the pail, and they fill the bill for the general-purpose animal better than anything else in our bovine world. Traverse America, traverse Great Britain and Ireland, traverse Australia, traverse Argentina, and everywhere you see Shorthorn eyes peering at you—ten head at least to one of any other breed. Trace the history of the Shorthorn in America, and you will find its pages largely made up of fads. It is the same thing with the Jersey in our milk breeds, but the writer takes up the other side of the question, because he knows it better. The original importer was looking to improve our scrub cattle, for the end is beef and butter, and so the early efforts were in this line. Soon there developed a spirit that ran to fashion, and fashion meant "Pure Bates" and "No surrender." This fad worked untold harm. Then came the red craze, which further intensified the misfortunes attending line breeding and fashionable pedigrees. The virgin fires of "red and nothing but red" are still kept burning. You might write and work forever, but your efforts to extinguish these foolish fires would still be unavailing. There is nothing of the chameleon in our Shorthorn breeders. They prefer a paper skinned, hairless red to the sappy mellow touch of the roan, and to-day the cry is all "Cruickshanks, Cruickshanks"—a beefy beast, but wanting in activity and hardihood for our Western world. The breeders of our White-faces and Blacks have followed a different course. To use an expression from one of our light operas, they have worked "to make the punishment fit the crime." Of course, we have our pedigree men among the above breeders, because they can not be dispensed with, but forms have not been sacrificed. The type needed or bred by some master hand in England is not necessarily the animal wanted on our Western farms, where semitropical suns pour down their relentless rays, nor does it follow that a bull fitted for an English meadow can be transplanted with good effect to the prairie or the valleys of the Platte River. What I say, and I say it without fear of contradiction, is that our Hereford and Aberdeen-Angus men have tried to meet the requirements of our ordinary breeders better than have the Shorthorn men. They have improved the type to meet the demands of our climate, of our feed, and the vast distances thousands of our cattle have to travel for water. They have met the conditions, not retreated from them. In the moments of success, which are the lot of our Hereford and Aberdeen-Angus breeders, it will take steady heads to keep the ship on a level keel.

The White-faces have taken the range country. The Blacks are breaking into the breeding districts of the West, slowly, it is true, on account of the laziness and want of energy of the males; but still so steady is the improvement (see stock yards records) of these beef cattle that their onward march can not be stopped. Our dressed beef men take these cattle in preference to all others, and my lesson in life makes me follow the practical in preference to the theoretical. I have more faith in Armour's scales than in Coate's Herdbook, and the Blacks on the block are the ideal of the butcher. I saw it in Scotland in early days; at Smithfield later, and nearly every day at the Chicago stock yards since. These facts teach us that the improving breeder must take lessons from his daily teachers, and in this fight of the feeder for recognition in the final court of appeal in our central stock yards will he find much that is useful and absolutely necessary to his existence in this age of competition. For the above reasons, stated frankly, the writer believes in the "Battle of the breeds" being carried on good naturedly at home and abroad.

TYPE.

Type is a wide word in the way it is used by our breeders of live stock. It has been used and abused, discussed and argued, until one is almost tired of it, and still no word is to be more used in the days that are coming. Types of cattle and sheep are going to be located in America just as they are in Great Britain. As you find the Shorthorn and the Ayrshire, the Hereford and the Aberdeen-Angus in their own peculiar localities, as you find the beautiful, graceful Cheviot on its native hills only, and the Cotswold on the downs that guard the Severn Vale, so the days are coming when, along with improvement, we are going to have "types" in different places and localities. See what a hold the Hereford has taken of the range. He is an ideal grazer. Some men will tell you solemnly that it is a mere boom that has sent the producer of the West crazy after the White-faces. On the surface much has been done in this line, but to find the real reason you must go to the root of the matter. You must impartially inquire into the whys and wherefores. We see in this movement a beginning of types in American cattle at least. The range is appropriating the Hereford because he suits the conditions and climate. He is naturally a grazer, with courage and perseverance, a fine traveler, and in many respects more indifferent to climate than any other beef breed.

But I go a step further, and say the breeders of pure-blood Herefords have improved their cattle so as to meet the views of the men who use their bulls. Twenty-five years ago what was the Hereford in America? A coarse-boned, heavy-horned, narrow-hipped beast, with no twist, deficient in his loin and rough in his forequarters. At that time the Shorthorn was leading the van in every direction. The Aberdeen-Angus and Galloways were not in numbers sufficient to compete with the other tribes. The progress of the Hereford has been forward, surely and not slowly. The breeders have met the issue. They saw the faults of their breed and started to remedy them. They have adopted the Shorthorn qualities of fine bones, good ribs and loins, fining down the shoulders, grasping at early maturity, and yet preserving all the good characteristics of the breed. Have our Shorthorns (still, and I think always to be, the premier breed of both America and Great Britain) made equal progress? The answer is certainly in the negative. From Bates we have run wildly to Cruickshanks—from roans to reds, and reds with no surrender, no room for argument, no listening to the voice of warning. If our breeders had retained the courage of Bates, the milking power of Knightley, the beauty of the Rose of Sharons, the sea-otter touch of the roans, with a dash of the Booth and Cruickshank early maturity and beef-making powers, then we would have had an animal that suited our Western country, and there is where we need bulls. I utter this criticism in no partial spirit. My experience is with beef, mutton, and pork, the ultima thule of all our live stock, and it is merely written to show forth from one point of view, and, as I think, the right one. What we need in cattle is to make beef and butter. In the struggle for existence we must meet issues, and during the past quarter of a century in our beef breeds the Herefords and Aberdeen-Angus have made wonderful strides, while our Shorthorns have actually stood still, or at least have made but little advance. The breeders of the latter have neglected type, the type, at least, which is needed in our Western country. We may, however, look for better things. The improved demand will bring forth better results, and then, too, different countries need different types. As we grow older we have more time to think and study the situation. The bull that suits the rich pastures of Illinois will not meet the requirements of the Colorado ranchman. We have reached the stage where type is not confined to the different classes of beef cattle, but goes further, reaching the localities and meeting distinct issues in all parts of the States.

So it is with sheep, but, as said above, this is an industry more various, needing more elasticity in its movements and ends than the beef, butter, or bacon business. There are two sources of income from the flock—mutton and wool. These products are as different as the poles. The one appeals to man's interior, the other to his exterior, and it does not follow when one is in demand the other follows suit. Consequently, the flock master has conditions to meet widely different from his brother breeder. The pendulum of his business tends sometimes toward wool. It is seldom that the best-wooled sheep meet the demand of the butcher. There is a continual wavering in the mind of the sheep man as to what course to pursue. Then there is the declining taste for large joints (more apparent now than ever before in our beef business). Still much is being done, and eventually we believe that the sheep of the American continent will find the spots where type is as necessary as in Great Britain. As the Cotswolds and the Cheviots are products of their native hills, firmly established, impregnable as Gibraltar from assaults of other breeds, it is certain that in the years to come we will have in Wyoming a general-purpose sheep widely different from that of Ohio or Ontario. It would be useless to prophesy what will be the leading breed. In a long stock-yard experience I have failed to make up my mind even vaguely on the subject. Certainly, we are drifting on to some more defined, stable foundation in our sheep business. As the Western flock master, at present the great producer, acquires land (as he is rapidly doing), and consequently increases his expense of production, he will need to look more narrowly to breeding only the best, or at least producing the type of sheep most suitable and profitable for his conditions. In this industry we are still in a transition stage, through which in our cattle business we have almost passed. Free range still serves the sheep man, but it will pass away also, and the men of the East will meet their brothers of the West on more equal terms.

THE AMERICAN BREEDER AS A PERSONALITY.

As a personality, the American breeder of fine stock is a wonderful study. In the pioneer days it was not the rich merchant, the great landed magnate, traveled and educated, but it was the farseeing farmer, with modest means, who did the real work. Such men as the Renicks, the Smiths, and the Browns, men of mark and shrewdness and with an intense love of animals, were the pioneers, and continue to be practically the leaders to-day. Sometimes a rich man drops into breeding, but his efforts are apt to be desultory, often faddish, and rarely successful. In Great Britain the leaders have been noblemen and large landed proprietors, who took up breeding not only for profit, but as an incentive to their tenants. It was a sort of patriarchal system that flavors of the best in feudal days. It is true, of course, that Bakewell, Bates, and Booth, and latterly Cruickshank, were not rich men. It was their brains that evolved their different types. They had more than brains; they had genius. Their work, however, has been carried forward in a large degree by the rich landowners for reasons stated above, while in the States and Canada the rank and file of our breeders are farmers who have fought and are still fighting their way, having to make ends meet often in the face of countless difficulties. There is a dash and enterprise among our breeders that savors of success, which, if not a financial, is at least a national benefit. The tussles that take place in the show yard; the personalities, reprehensible in themselves, are but indications of that spirit of emulation which eventually leads on to bloodless battles won and new fields conquered. With all this collective vitality and wonderful energy there is no single case in our knowledge or remembrance at all comparable with the above British breeders. Maybe Abram Renick is of the same class. He approached them in his methods and foresight. His Rose of Sharons were a beautiful lot of cattle. The adjective beautiful is used advisedly, because his herd could not be called the perfection of bovine structure. But his life work was a great one. He had one ideal, and he attained it. He wanted a neat, small, rather effeminate animal, pleasant to the eye, with its mild expression and mellow hide, low-legged, active, a grazer with rapid maturing power; but to my idea there was a want of scale, and his bulls wanted that masculine power, the impress of head and neck, which you must have in a male animal, whether it be a bull, a ram, or a boar. Treating this great breeder with all due respect, we can not place him on the same pedestal with the great lights that illuminated the first days of Shorthorns in Britain or the climax of Cruickshank's career; but he stands far and away ahead of all other American breeders of any class of live stock, and the world, not only the continent, is richer for his efforts.

The criticism passed upon our breeders of all classes of live stock is that their methods are spasmodic. The nervous energy of our people leads on to this state of affairs. The writer has seen many herds of cattle and flocks of sheep, but scarce in one was there that remarkable uniformity or family likeness, that concentration of good points, that at once attracts the eye and gives character to the herd. The answer to the criticism is that we have not had the time, but we must endeavor to reach more uniformity. What a charm uniformity has to the buyer in our stock yards! From the intense practical ideas of our dressed beef men and Eastern buyers, the improving breeder can draw many a lesson.

In the stock yards of late years we have had remarkable instances of uniformity from the feed lots of some of our breeders of Aberdeen-Angus, perfect marvels, many of the lots of the best type of the beef animal, an Illinois herd marketing in December a lot of wonderful black beeves that on the hoof realized $8\frac{1}{4}$ cents per pound, the highest figure of the past fifteen years. The credit lies with our best breeders of this class for having advertised their products by practical illustration; no paper warfare, but by concentrating the facts in the beast before you. Probably the best work, relatively, of our breeders of late years has been with this class of cattle. They have shown us by their sacrifice in feeding steers that, as bulls, would have been a credit to any pasture, the wonderful powers of the Aberdeen-Angus as a beef animal; in fact, they have given us the living pictures, and remarkable ones they have been. The Aberdeen-Angus breed, transplanted from its native home to our shores, owes much to the personality of the men who have handled these cattle. In truth, they have been improving breeders, men of earnest devotion and single-mindedness, the image of the bovine Black ever in their eye, devotees to art in the realms of agriculture, just as keen as were the Greeks in pursuing the paths of Parnassus.

CONCLUSION.

For over twenty-five years the writer has been intimately connected with American live-stock affairs. What a transformation has taken place! The general advance has been by leaps and bounds. True it is, that some classes of stock have forged ahead of others, but as a great collective forward movement nothing, so far as known, equals it. West of the Missouri most has been done. It was a virgin soil after the war, and the pioneers and ranchmen drew on the stocks of the older States for blood, in the use of which the source of supply has been outpaced; at least the general quality of the cattle is better than in the older States. There is still room for improvement. The ordinary breeder of cattle and sheep in the Central States has been careless during the past decade. He has allowed the Western pasture man and small ranchman to eclipse him in quality. He neglected his opportunities when bulls were cheap and plentiful. The improving breeder can only be kept going by selling his wares to the raiser of stock for market. The impulse of higher prices is remedying this evil and balancing to a great degree the different sections of the continent in blood and quality.

DEVELOPMENT OF TRANSPORTATION IN THE UNITED STATES.

By Angus Sinclair,
Editor Locomotive Engineering.

Mechanical and Business Problems.

Lord Bacon truly says that there are three things which make a nation great and prosperous—a fertile soil, busy workshops, and easy conveyance of men and commodities from place to place. The history of the world has proved Bacon's words to be true, but there have been nations blessed with a fertile country and busy workshops which have tried to get along without easy means of transportation, because of sectional differences concerning the defraying of the expense of constructing artificial arteries of intercommunication. The regions served by water transport were opposed to building roads for the convenience of localities remote from sea, lake, or river, and thus conflicting interests retarded the progress of some countries for the time being and left great spaces of fertile regions undeveloped.

In the course of two-thirds of a century a vast wilderness on the American Continent has been changed from gloomy, untrodden forests, dismal swamps, and pathless prairies into the abode of a high civilization. Prosperous States, teeming with populous towns, fertile farms, blooming gardens, and comfortable homes have arisen from regions where formerly savage men and wild animals were the sole tenants. A powerful factor in effecting this beneficent change has been the building of railroads.

EARLY PRESSURE OF PRODUCTION UPON TRANSPORTATION.

Projects for providing facilities of transportation by rail originated almost simultaneously in the British Isles and the United States. Both countries were badly supplied with highways on which wheeled vehicles could convey heavy loads; both had tried canals and found them unsatisfactory in some respects. The increase of production of commodities faster than the means of moving them led enterprising men in both countries to look in the same direction for relief.

The conditions of urgent necessity which led to the inventing of the steam engine were repeated as the volume of produce and merchandise to be carried went beyond the capacity of water carriage and inferior roads. The steam engine came when great properties were deteriorating because horse power was incompetent to concentrate great effort in limited space. It was a foregone conclusion that the steam engine would be applied to locomotive purposes as soon as the horse proved unequal to the work of supplying the motive power for roads and canals.

The application of steam to water transportation delayed for a time the advent of the locomotive, but thoughtful men had glimpses of what the steam engine might do in moving loads on land almost as early as attempts were made to use steam in propelling boats.

THE RAILROAD TRACK.

The railroad structure provided a way for the wheels of a vehicle to run upon a smooth, hard surface, where obstacles to progress, such as sinking of the wheels into soft places and mounting over stones or other projecting obstructions, would not be encountered. Such roads were to be found in various localities hundreds of years before the steam engine was invented. There are many traces of what were really stone railroads to be found in parts of Asia and Africa, where an advanced civilization flourished thousands of years ago. The rows of huge stone blocks, worn with myriads of wheels, are in many places the most substantial traces of an enterprising people long passed away. The writer has seen in the streets of Italian cities stone blocks laid down parallel, with a depression to keep the wheels of vehicles in place, and these make as smooth a roadbed as the inside surface of car-track rails provide for the truckmen of our large cities.

For hundreds of years stone ways were used in Germany and other countries in connection with quarries and coal pits. They were introduced into Great Britain in the eighteenth century. This kind of crude railroad was known by the name of "tramway," and Englishmen say it originated from the name of Outram, a noted individual, who took some interest in pushing these friction-reducing roads. As the word "tram" is German and has been used by all northern nations for a thousand years, the claim of Outram to the word is not acceptable. His name probably originated from the word, which was given to the man who drove the oxen outside of the trams of the plow. Outram was the outside man.

Burns, who wrote before Outram's time, in his "Inventory," says:

> An auld wheelbarrow more for token
> Ae tram and baith the legs are broken.

In the days anterior to railways the intercommunication between the people of different districts in Great Britain was not at all intimate, but those with the same interests seemed to find out what the others were doing. The British Isles are inflicted with rain, and rain is not good for dirt-made roads. It is, then, easy to imagine how well the invention of some coal miner was regarded who introduced tram rails to carry the wagons from the mine to the staith, or wharf, where the coal was dumped into ships.

One could not tell the coal-mining world of Great Britain at the beginning of this century much that was new about trams. The tramway began with long blocks of stone, that gave place to parallel wooden stringers for the wheels to run upon. The hand of progress covered the stringers with iron strips. Then some one found out that a cast-iron rail simplified matters, and a flange was put upon the wheels to prevent them from jumping the track. This was the condition of the world's "permanent way" when people of advanced ideas proposed to use it for steam-driven locomotives.

NEED OF THE LOCOMOTIVE.

The nineteenth century had not advanced many years when people in the United States began to realize that something better than canals was necessary as a means of intercommunication if a great part of the nation's territory were to be opened up to settlement and civilization. There are numerous navigable rivers and long-reaching lakes on this continent, but geographically they are far apart, and there is no means of reaching vast regions except by land transportation. To the ordinary thinker a system of substantial macadam roads would have solved the difficulty as far as draft animals could have aided, but these roads were not tried to any extent.

The pinch of necessity wonderfully quickens the inventive faculties. Long before a mile of tramway was built in the United States in connection with coal mines, engineers and farseeing public men were discussing the possibilities of the steam engine as a means of accelerating land travel, and projects began to be agitated in different States to construct railways, or tramways, on which the steam engine could do the work of hauling the cars.

Those who looked favorably upon steam engines as motive power on railroads were a small minority, and they were considered by the majority as cranks and visionaries. Those regarded as sensible, progressive men, a little ahead of their time, favored horses for motive power.

The problem that public men were interested in was, How are we going to move our merchandise, and coal, and ore to the nearest point of water navigation? The transportation of passengers received little consideration from the early railroad schemers.

It might here be mentioned that had James Watt never lived, the use of the steam engine for transportation purposes would have been given to the American people just as soon as it was. Oliver Evans, a native of Delaware, invented the high-pressure, high-speed engine as an improvement on the Newcomen atmospheric engine when Watt was working out his ponderous slow-moving improvement on the same engine. The United States has been the land of high-speed, high-pressure engines, the type most suitable for locomotive purposes, and Oliver Evans was the originator.

The need for the locomotive was much more urgent in the United States than it was in any other country. There were long stretches between Western rivers and Eastern estuaries that needed to be connected. There were no well-constructed roads of any consequence, and such roads, had they existed, could not have offered rapid transportation, so the railway was the chief hope of connecting the remote territory with markets and the seaboard.

FIRST AMERICAN LOCOMOTIVE.

The first locomotive that was tried on the American Continent to run on rails was imported from England by the Delaware and Hudson Canal Company. It was selected and brought here by Horatio Allen, a pioneer engineer, who was interested in railroad enterprises. The engine was taken to Honesdale, Pa., and tried there in August, 1829. Mr. Allen reported that it was too heavy for the railroad structure, and its use was given up. The engine weighed only 7 tons, and there was some diversity of opinion about its being too heavy for the railroad, but Mr. Allen's decision was final. Several engines of the same type worked for years successfully on English railways. From what is known about the structure of the road, engineers now agree that it was sufficiently strong to support twice the weight of Allen's engine, known as the "Stourbridge Lion."

The first thirty years of the nineteenth century were for Americans the period of speculation about the probable success of railroad building and the utility of the locomotive. Then the people set to work to build railroads, and within ten years (1840) the country had 2,755 miles of railroads and tramways.[1] For a few years there was decided uncertainty that the locomotive would be a practical form of motive power, and Allen's fiasco with the "Stourbridge Lion" helped to make the capitalists who were investing their money in railroad building timid about ordering locomotives while they could operate their cars with horses.

EARLY RAILROADS AND LOCOMOTIVE BUILDING.

The South Carolina Railroad Company was one of the earliest in the world to decide that its railroad should be operated by locomotives, and the operation began in 1827, very soon after the beginning in England.

People of Baltimore, who have always shown much zeal in supporting enterprises likely to bring trade and commerce to the city, obtained in 1827 a charter from the legislature of Maryland to construct

[1] Report on Transportation by Land, Eleventh Census, by Henry C. Adams, special agent, p. 6.

a railroad from Baltimore to a point on the Ohio River. The building of the Baltimore and Ohio Railroad was begun without loss of time with imposing ceremonies. In the early part of 1830 the road had been finished from Baltimore to Ellicott Mills, a distance of 13 miles, and the company began operating that part by horses. There were several sharp curves on the route, and a belief was general that a railroad having curves could not be operated by locomotives. Peter Cooper, whose fame as a philanthropist is well known, was a resident of Baltimore at that time, and he did not share the popular belief that locomotives would not be capable of working around curves, so, to demonstrate the faith that was in him, he built a small locomotive in the Mount Clare shops, Baltimore, and tried it on the road. It was a very tiny affair of about 1½ horsepower, but it proved that a locomotive could haul a load on a curved road.

Cooper's experiment increased public confidence in the efficiency of locomotives, and the demand for this kind of engine increased as steadily as pieces of railroad were finished.

Machine shops capable of building locomotives were not very numerous, but a few shops undertook the work and succeeded very well under the circumstances. The first practical engine intended for everyday work was built by the West Point foundry, New York, for the South Carolina Railroad. It was a small engine, with a vertical boiler, but it worked as satisfactorily as the English locomotives built at the same time (1830). The West Point foundry continued to build locomotives for a time, and improved on the design and capacity of the first engine. Among their most celebrated productions was the "De Witt Clinton," built for the Mohawk and Hudson Railroad.

Shortly after the experiment with Peter Cooper's model locomotive on the Baltimore and Ohio the management of the company advertised for locomotives of American manufacture, offering to pay liberally for them. In due time this brought five engines, all built at different places, all different in design, and none of them imitating English models. The preference was given to an engine built by Davis & Gartner, of York, Pa. This engine had a vertical boiler and was for a time the type of locomotive used by the Baltimore and Ohio Railroad.

After this there were locomotive-building shops to be found in several towns. Mathias Baldwin had entered the business the year previous, and his "Ironsides," the second locomotive built in the United States, was running on the Germantown road, where it was doing good work, although the company published a standing notice that the locomotive would start daily with a train of passenger cars if the weather was fair, but that on rainy days horses would pull the train.

By 1840 there were about two hundred and seventy locomotives working on fifty-six railroads that were partly finished; but the greater part of the mileage was still operated by horses. It may seem surprising that so many locomotives should be employed on such a short mileage when horses were doing most of the work, but a locomotive during the first railroad decade was very little larger than the fire engine of to-day, and great care was taken to prevent it from working hard. The weight of the first Baltimore and Ohio regular locomotive was $3\frac{1}{2}$ tons.

EARLY FREIGHT RATES.

The greater parts of early railroads were projected to join two or three towns by easy communication or to provide the means of carrying freight from the interior to harbor towns that were not well provided with water transport. Complaints were made in the interior, where farm products were raised, that the cost of transportation to a market often exceeded the value of the shipment. When we examine the railroad rates charged in 1840, we are not surprised at the complaints made by agricultural communities. A good many of the railroads were chartered as turnpikes, and any person could haul cars over them on paying the legal toll charges. This plan, which caused great confusion, did not have the effect of cheapening transportation. For years after steam motive power was generally introduced private cars were hauled, both freight and passenger, payment being exacted on a tonnage basis.

In 1840 Mr. W. H. Wilson, engineer of the Columbia and Philadelphia Railroad, reported that the rates of toll for the use of the road varied from 6 mills to 4 cents per ton-mile. There were twelve different rates, the average being 2 cents per ton-mile. It was said that in the first nine months of the operation of the Baltimore and Ohio the cost per ton-mile was 6 cents. In 1837 the charges for carrying freight on a few leading railroads were as follows, in cents, per ton-mile: Baltimore and Ohio, $4\frac{1}{2}$; Baltimore and Washington, 4; Winchester and Potomac, 7; Portsmouth and Roanoke, 8; Boston and Providence, 10; Boston and Lowell, 7; Mohawk and Hudson, 8. At that time passengers were charged between 2 and 3 cents per mile on the roads that carried them.

Although the rates were high from our present standpoint, the railroads did not obtain much profit from the work done. This arose from a variety of causes. The railroads had nearly all been built in an inferior fashion, with material that was too light for trains, although engines and cars were also very light and poorly built. On most of the lines the business offered was very small, but the trains had to be run, no matter what the extra expense was.

As late as 1873 Gen. Herman Haupt, general manager of the Atlanta and Richmond Railroad, testified to a Senate committee that local rates were $3\frac{1}{2}$ to 4 cents per ton-mile, and that local passengers were charged from 4 to 5 cents per mile. These rates, he acknowledged, were about twice as high as those charged on Northern railroads. He justified the high charges on the ground that business was small. He was dealing with conditions that existed on nearly all railroads up to 1860.

The men in charge of the operating and of the machinery of railroads had to learn their business by hard and often expensive experience. But they made steady progress, and every succeeding year, up to a certain point, saw the railway transportation done at reduced expense.

RAILS AND ROADBED.

It was soon found out that strap rails and other forms of weak permanent way, laid on a soft, yielding roadbed, made the worst kind of a foundation upon which to build up a prosperous business. Railroad operators were not long in finding out that locomotives weighing under 10 tons were too weak for hauling paying loads, and that the small cars used had too much dead weight for the paying load. From 1840 to 1860 the improving of the weak points named occupied the attention of the most progressive railroad officials.

When there are good prospects for obtaining plenty of goods to transport by railway the most important preparation for doing the work at low cost is to have a good roadbed and a substantial track properly laid upon it. The engineers who supervised the building of early railroads believed that the first requirement of a good track was to have it as unyielding as possible. The first part built by the Baltimore and Ohio served for several years as a model for other railroad builders. A roadbed was first graded as nearly level as possible. A small trench was then made for each track and filled with rubblestone. On this were laid blocks of granite or other rock, about a foot square and as long as possible. The upper face and inner surface of these blocks were dressed perfectly smooth. Bars of iron, about an inch thick, were then laid on them close to the inner edge and fastened there.

In some sections granite or other rock blocks were laid at intervals with wooden stringers, to which the iron rails were fastened.

As late as 1841, in the building of the Erie Railroad, one of the presidents had piles driven for 100 miles on dry land, to make a substantial support for the stringers that were to carry the rails.

A few years' experience proved that the unyielding support to the rails turned the structure into a long anvil, on which the rolling stock was hammered to destruction. All who could afford the expense lost no time in putting in cross-ties to support the track.

Great varieties of rail sections were tried during the first twenty years of railroad building. First there was the plain strap noted for its "snakeheads," which was a form the rail sometimes took at a loose joint. Frequently those snakeheads forced their way up through the car floor. Contemporaneous with the strap was the fish-bellied rail, which was deeper in the middle than at the ends. This rail had to be kept in position by cast-iron chairs, secured to the stringers or cross-ties. Next came the U, or bridge, rail, laid with the flanges spiked to the supports. Eventually the T-rail came and gradually sent the others to scrap dealers.

IMPROVEMENTS IN THE ENGINE.

The first direction that the improvement of rolling stock took was the extension of the wheel base of the engine so that the weight should be distributed over as much rail length as practicable with the lightest possible weight on any one spot. This movement was really begun in the United States, when, in 1831, John B. Jervis, chief engineer of the Mohawk and Hudson Railroad, put a four-wheel truck under the front end of an engine that was built under his supervision. This worked so well on weak, uneven track that it was gradually adopted by nearly all American railroads.

The coal railroads of Pennsylvania, Maryland, and New York, which frequently had more business than their motive power could handle, began using engines about the middle of the century which were extraordinarily heavy and powerful for that time. The companies using those engines could afford to build and maintain very substantial permanent way, which was not the case with the average railroad company. At the same time the engine for ordinary train service was working into an established form. By 1860 engines weighing about 20 tons were becoming common, and most of them were carried on two pairs of coupled driving wheels and a four-wheel truck in front. That form came to be known as the "American" engine, and it held almost exclusive control of the motive-power field with regular enlargements until about 1880. These engines were suitable for any service, passenger or freight, when used on fairly level roads, and are to-day the most popular motor ever put in front of a train.

The locomotive of 1900 is an example of steady evolution, and its leading features are survivals of the fittest. Vast improvements have been made in quality and finish of material. Certain important changes have been effected, among which these may be mentioned: The putting of iron and steel into frames and driving wheels that formerly were partly of wood; counterbalancing the driving wheels; making the fire box suitable for burning coal instead of wood; using equalizing levers between the wheels; placing the cylinders horizontally instead of vertically or inclined; using steel tires instead of iron; using steel for boilers instead of iron and for fire boxes instead of iron or copper; using iron or steel for tubes instead of brass. All these improvements have helped to increase the durability of the engine, to make it more efficient, and therefore to enable it to reduce the cost of hauling mile-tons of freight or passengers. Other changes made in the interests of economy are extremely high boiler pressure, increase in size, and using the steam on the compound system.

STEEL RAILS.

Steel rails began to be introduced about 1867, and they steadily forced iron rails out of use, except for places where the traffic was very light. Engineers who have made the subject a special study say that a steel rail is from 8 to 15 times more durable than iron and is much less liable to breakage throughout the whole of its use. The invention of cheap methods of making steel rails has had a stupendous effect upon transportation. It brought the cereals of regions west of the Missouri River and of the remote Northwest into competition with the grain-raising districts of the Eastern States and of Europe and Asia; it caused a semirevolution in farming business in the British Isles, and strongly affected the condition and fortunes of millions of people. While inflicting injury on the interests of the few, the invention exercised a distinct beneficent influence on the many.

The iron rail and the 25-ton locomotive had pushed settlement and civilization far beyond the limits possible when the mule-hauled wagon formed the means of transport to waterways. Steel rails and huge locomotives make the railroad a close competitor with waterways in the cost of transportation; these have also made the capacity for reaching remote places almost unlimited.

It was only after the introduction of steel rails that railroad men began to grasp the conditions necessary to move a unit of passengers or freight at the least possible expense. The principal conditions are powerful locomotives, loaded to their utmost capacity with large cars carrying heavy loads and run over a fairly straight and level road. For the last ten years all competent railroad managers have been working in this direction.

Improvement in permanent way and in motive power greatly reduced the cost of transportation, but a great change in the methods of railroad operating and management preceded the physical improvements referred to.

CONSOLIDATION AND EXTENSION OF RAILROADS.

It has already been mentioned that most of the early railroads were built to connect towns or waterways. They were mostly short roads that did not attempt to cooperate with one another in moving freight or passengers beyond their own limits. This led to very annoying delays and extra handling of freight. The line, for instance, between Albany and Niagara was in the hands of many separate companies that seldom worked in harmony, and nearly all other lines that were links in through routes were managed in a similar manner. By 1850 the people had become tired enough of the unnecessary discomforts endured on long journeys, and they began to demand radical reform. This gave personages who became known as "railroad kings" their opportunity.

ECONOMICS OF THE GAUGE.

In connecting disjointed lines the consolidators lost an opportunity which may cause much inconvenience in coming years. They found a great variety of track gauges and chose the narrowest, 4 feet 8½ inches, now known as the standard. That gauge is too narrow for admitting of a properly designed boiler upon a large locomotive. Many locomotives are already at work that have reached the limit of their capacity, because the limited gauge prevents the boiler from being made larger. To obtain a large boiler it has been raised as high as bridges and tunnels will admit, and it can not be made any longer with economy, so that the question has been raised whether this country has not already nearly reached its limit of cheapness in railroad transportation. If the gauge had been made 6 feet, the Erie standard, or 5 feet 6 inches, which was the gauge of many Southern roads and that of Canada, the possibilities of making railroads compete successfully with water carriage would have been greatly increased. When all the leading railroads use locomotives of the greatest possible capacity for the gauge, and cars are made to carry the maximum load that can be safely conveyed on two four-wheel trucks, the cost of transportation will be reduced, but not to a radical extent. It is believed in some quarters that the bottom cost has nearly been reached unless some revolutionary change is made in the track and motive power.

One of the most curious facts met with in railroad history is the influences by which certain track gauges were established. The settling of the gauge likely to prove most convenient for the business to be done is an engineering problem which ought to have received careful study and profound calculation. Instead of that, the gauge was generally decided by some whim. In 1840 there were thirty-three separate railway companies in Great Britain, with 1,552 miles of track, and they had five different gauges, ranging from 4 feet 8½ inches to 7 feet—the narrowest gauge having more mileage than all the others. The former was George Stephenson's gauge, and it was established in a curious way. The gate openings of the first tramroad Stephenson was connected with were just sufficiently wide to permit wheels extending 5 feet to pass. At that time the flange of the wheel was on the outside. When the Stockton and Darlington Railway was built Stephenson put the wheel flanges inside. The width of the rail head was about 2 inches, so the inside gauge was 4 feet 8 inches. When the Liverpool and Manchester Railway was under construction the engineers concluded that it was better to give the wheels plenty of side play to make fast running easy, and they widened the gauge one-half inch, making it 4 feet 8½ inches.

The success of the Liverpool and Manchester Railway made George Stephenson a great man, and others were ready to imitate what he had done, so his gauge was adopted by most of the British railways.

He had locomotive building works that supplied many of our early railroads with engines, and the track gauge was generally established to fit the wheels of the engine. The South Carolina track was laid to 5-foot gauge, and the tendency in the South was to follow that width, but toward the Ohio River and some other Southern districts 5 feet 6 inches was the favorite gauge.

There was more confusion in the North. The roads that began with Stephenson engines had mostly 4 feet $8\frac{1}{2}$ inches gauge; but there were to be found gauges of 4 feet 9 inches, 4 feet 10 inches, 4 feet 11 inches, and 5 feet. Canada had 5 feet 6 inches, and the Erie road 6 feet. The wide gauge was adopted for the Erie because the chief engineer said that the grades would be so heavy that enormously large locomotives would be needed to haul the trains and that the narrow gauge could not accommodate the size of engines necessary. The president favored the wide gauge because he did not wish the road to have facilities for interchange with other roads that might be the means of carrying trade away from New York City.

RATES IN RECENT YEARS.

For the last thirty years the rates for the transportation of freight have been steadily reduced. In 1854 a leading trunk line with terminal in New York received an average 2.58 cents per ton per mile; in 1899 the rate had fallen to 0.517 of a cent. In 1870 twelve leading railroads received an average of 2 cents per ton-mile for freight, and in 1898 it had fallen to 7.53 mills. The average rate for passengers in the latter year was 1.973 cents per mile.

The rates for carrying passengers have not decreased in proportion to freight charges, but it is doubtful if the railroad companies earn more in proportion, for the cost of hauling trains has been greatly enhanced by the introduction of heavy, luxurious cars and accelerated speed.

Expansion and Progress.

In the foregoing pages much space has been devoted to a consideration of the mechanical difficulties that were encountered by railroad engineers and constructors in the extension of the railway system of this country, for the reason that these difficulties were of a fundamental character and needed to be overcome before distant agricultural regions could be placed in practical and economical communication with their markets. In previous treatments of this subject, the dependence of agriculture upon these technical and fundamental features of transportation has not received due importance; hence, the present attempt to explain the indebtedness that agriculture and its extension in the United States owe to the mechanic, the engineer, the railroad constructor, the inventor, and the railroad manager. In the remainder of this paper attention will be given to industrial and economic features.

ROADS AND CANALS.

When the nineteenth century began the inhabitants of the States forming the Union were settled within easy reach of navigable streams or estuaries of the ocean, which provided indifferent means of transportation. The most fertile land was often to be found farther from the waterways, but the expense of carrying produce to the market was in such cases greater than the value of the goods.

A glance at the map of the United States will show how bountifully nature has provided the Atlantic coast with inland waterways that extend far into the interior of the country. By the aid of these the nucleus of a great nation was established with practically no aid from artificial means of transportation. During the colonial period there was not enough State or national feeling to induce the people to join their energies in pushing enterprises, such as roads and improved waterways, for the public good. The long struggle of the Revolutionary conflict impoverished the people, never rich in the world's goods, and the close of the eighteenth century found the Government too poor to undertake the execution of public works greatly needed to aid the country in a progressive career.

Sentiment in favor of making better means of inland transit was, however, kindled, and it gradually but surely warmed up public opinion to engage in united efforts to carry out public works for the good of the country at large. The first useful manifestation of this sentiment was the building of good roads between important trade centers. Then came agitation in favor of the construction of canals. That the making of roads and canals did not achieve much progress in the early years of this century was due more to the poverty of the people than to their want of inclination.

The war of 1812 delayed to a great extent the construction of roads and canals, but peace was scarcely established when these public improvements were pushed with renewed vigor. By this time the invention of the steamboat was imprinting its mark upon the country and opening up prospects of extended inland commerce which never had been dreamed of when the century began.

IMMIGRATION.

The nineteenth century has seen a mighty emigration, more stupendous than anything that happened in ancient times, and it has gone on so quietly that few people realize its vast proportions. This has been the emigration of people from Europe to the United States. The principal part of this immigration, which in itself has been sufficient to form a great nation, has happened since the beginning of the railroad era, and the extending of new railroads has constantly opened new worlds, where industry and thrift made possible conquests of wealth and comfort, such as no other movement of the human race has brought to the enterprising seekers after fortune.

THE STREAM OF TOILERS FROM EUROPE.

With road building, canal construction, and the sending of steamboats farther and farther inland, the United States was becoming the greatest center of commercial activity and enterprise in the whole world. The fame of this land of liberty extended beyond the Atlantic, and thousands of people, destitute of land or starving in forced idleness, looked to the United States as a land of promise, where industry would reap the reward of food, raiment, and comfort.

That started a stream of emigration which rose like a rippling brook, and increased as it advanced until it became a mighty river.

It is estimated that in the years from 1789 and 1820 about 250,000 immigrants came to the United States, a large proportion of them having arrived in the latest decade. Although the disturbance of the war of 1812 had prostrated enterprise, the last few years of the second decade of the century witnessed the inauguration of industrial activity, and were the beginning of the nation's irresistible march on the crusade of peaceful triumphs.

In the decennial period from 1821 to 1830 the immigrants numbered 143,439, and this brought the country to the beginning of the railroad-building period. The flood of immigrants then increased very rapidly, for the people in Europe found out that thousands of hands would be needed in the construction of railroad works, while others learned that the railroads were opening up new territory for settlement, where land could be bought cheaply, while a market would be open for the produce raised. In the decade 1831 to 1840 the Government records show that 599,125 immigrants arrived.

The stream of emigration was now becoming a flood. From 1841 to 1850 the population was increased by 1,713,251 people who came from beyond the seas. It went on increasing from this source till, in the decade from 1881 to 1890, it reached the immense proportions of 5,246,613. That was the high tide. From 1821 to 1899 immigrants to the number of 18,823,668 came to find homes in the United States. In the year 1882, which was the flood of the tide, the country received almost 800,000 immigrants.

The world never before saw anything comparable with this tremendous movement of people in so short a space of time. The population that Europe has thus lost in a hundred years is about equal to two-thirds of the population of Great Britain and Ireland in 1861, and is a little less than this fraction of the number of inhabitants in the United States in the same year. It represents five-sixths as many people as Great Britain and Ireland gained in population in the first ninety years of this century. If the ships on which these emigrants embarked carried, on an average, 500 passengers, more than 38,000 round trips have been made in ferrying them to their new homes.

No probability can be discerned that any later century will see the equal of this migration. The fairest parts of the world that were wildernesses in 1800 now teem with industry and population. There are no more virgin lands in abundance to occupy in this country; no more such enticements to draw millions from the homes of their fathers.

Much of this vast concourse of people rested not in towns upon their arrival, but marched out bravely to lands that had never felt the plow and to forests unmarked by the ax, and there by patient toil proceeded to enrich themselves and the nation under whose industrial flag they had enlisted.

INCREASE OF POPULATION, AGRICULTURE, AND RAILROAD MILEAGE.

The means of railroad transportation advanced steadily with the growth of population. Although early in the century a movement had been started for the construction of good roads, the work done scarcely made a mark on the map of the United States, and the people who settled more than a day's journey from navigable water or canals depended on railroads as almost their sole means of transporting their produce to markets. To them the railroad was looked upon to perform the functions done by turnpikes in other countries. On this account the people have given extraordinary encouragement to the building of railroads.

In 1840 the population of the country was 17,069,453, and there were 2,755[1] miles of railroads in operation, or 0.16 of 1 mile, about one-sixth of a mile for every 1,000 people. In the census year 1840 Ohio, Pennsylvania, New York, Virginia, and Kentucky raised 57 million bushels of wheat. During the same year Tennessee, Kentucky, Virginia, Ohio, and Indiana raised 181 million bushels of corn. The total volume of agricultural exports that year was worth $92,548,067.

The next decade, ending in 1850, found the population increased to 23,191,876 people, and the railroad mileage to 8,571,[1] or 0.37 of 1 mile for every 1,000 of the population. Pennsylvania, Ohio, New York, Virginia, and Illinois in 1850 raised 63½ million bushels of wheat, and Ohio, Kentucky, Illinois, Indiana, and Tennessee raised 281 million bushels of corn; Alabama, Georgia, Mississippi, South Carolina, and Tennessee raised 2.04 million bales of cotton; New York, Ohio, Pennsylvania, Virginia, and Tennessee had $222,900,000 worth of farm live stock on hand. The exports amounted to $108,605,713 in agricultural produce.

In 1860 there were 31,443,321 people, and 28,920[1] miles of railroad, or 0.92 of 1 mile to every 1,000 of the people. During 1860 Illinois, Indiana, Wisconsin, Ohio, and Virginia raised 84½ million bushels of wheat, while Illinois, Ohio, Missouri, Indiana, and Kentucky raised 397 million bushels of corn; Mississippi, Alabama, Louisiana, Georgia, and Texas raised 4.1 million bales of cotton; and the farms of New

[1] Report on Transportation by Land, Eleventh Census, by Henry C. Adams, special agent, p. 6.

York, Ohio, Illinois, Pennsylvania, and Kentucky had on hand 388 million dollars' worth of live stock. The value of agricultural exports was $256,560,972.

In 1870 the population had risen to 38,558,371, and the railroad mileage was 49,168,[1] or 1.28 miles to each 1,000 of the population. During that year Illinois, Iowa, Ohio, Indiana, and Wisconsin raised 141 million bushels of wheat; Illinois, Iowa, Ohio, Missouri, and Indiana raised 383½ million bushels of corn; Mississippi, Georgia, Alabama, Louisiana, and Texas raised 2.17 million bales of cotton; New York, Illinois, Ohio, Pennsylvania, and Missouri had on their farms 646 millions of dollars' worth of live stock. The export of agricultural produce was worth $361,188,483.

During the decade ended in 1880 the population increased to 50,155,783, and there were 87,724[1] miles of railroad, or 1.75 miles for each 1,000 inhabitants. Illinois, Indiana, Ohio, Michigan, and Minnesota raised 214½ million bushels of wheat in 1880, while Illinois, Iowa, Missouri, Indiana, and Ohio raised 1,030½ million bushels of corn, Mississippi, Georgia, Texas, Alabama, and Arkansas raised 3.89 million bales of cotton, and Illinois, Iowa, New York, Ohio, and Missouri had 574½ million dollars' worth of live stock. The value of agricultural produce exported that year was $685,961,091.

In the 1890 decade the population was 62,622,250; there were 163,597[2] miles of railroads, 2.61 miles for every 1,000 of the population. Minnesota, California, Illinois, Indiana, and Ohio in 1890 raised 203½ million bushels of wheat; Iowa, Illinois, Kansas, Missouri, and Ohio raised 1,173 million bushels of corn; Texas, Georgia, Mississippi, Alabama, and South Carolina raised 5.48 million bales of cotton, while the farmers in Iowa, Illinois, Missouri, Kansas, and New York had on hand 778 million dollars' worth of live stock. The export of agricultural products aggregated $629,820,808.

In 1900 the estimated population is 75,000,000; the miles of railroad, 190,000,[3] or 2.53 miles per 1,000 of population.

In 1899 Minnesota, North Dakota, Ohio, South Dakota, and Kansas produced 234 million bushels of wheat; Illinois, Iowa, Kansas, Nebraska, and Missouri raised 1,114 million bushels of corn; Texas, Georgia, Mississippi, Alabama, and South Carolina raised 8.2 million bales of cotton, and the farms in Iowa, Texas, Illinois, Kansas, and New York contained about 621 million dollars' worth of live stock.[4] The value of agricultural products exported was about $784,999,009.[5]

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[1] Report on Transportation by Land, Eleventh Census, by Henry C. Adams, special agent, p. 6.

[2] Report of Statistician of Interstate Commerce Commission, 1898.

[3] Estimates of the Department of Agriculture, based on reports of the Statistician of the Interstate Commerce Commission.

[4] In 1900, without swine, $784,989,087.

[5] Bureau of Statistics, Treasury Department (subject to revision).

LONG-DISTANCE TRANSPORTATION.

While the United States for many years continued to be almost exclusively an agricultural country, the center of population has remained near the middle of the settled portion. A century ago there were very few settlers west of the Appalachian Mountains except in Kentucky, Pennsylvania, and Ohio. The people were mostly settled on a strip about 1,600 miles long, extending along the coast from Maine to Alabama, the width depending upon the number and character of the rivers that provided means of transportation into the interior. Up to 1840 the center of population moved within a radius of 200 miles from Washington, D. C.; then it moved slowly westward. In 1850 it was near Parkersburg, W. Va.; in 1860 it was near Chillicothe, Ohio; in 1870 it was 48 miles east by north of Cincinnati, Ohio; in 1880 it was 8 miles west by south of Cincinnati and in 1890 it was 20 miles east of Columbus, Ind.

The center of population after 1840 began to be more and more influenced by the increasing population of the manufacturing and mining districts, and the greater part of the agricultural products came to be raised in States that were a long distance away from the center of population. It will be noticed that in 1840 and 1850 New York, Pennsylvania, and Virginia were among the best wheat-raising States, but after that the raising of cereals moved gradually to the Western States. This movement became very rapid after the introduction of steel rails enabled railroad companies to make material reduction in freight charges.

After railway construction began a part of the westward movement of population was surging in advance of railroad building, the enterprising people being contented to go forward and wait for the railroads that would give them easy communication with the commercial world by the time they had produce to sell and were ready to purchase the commodities that the outer world would supply. They went by rail, by boats on lakes and other waterways, and then by prairie schooner found their way to the more fertile regions open for settlement.

It was not safe, however, to settle far from a point of shipment by rail or water, because produce could be carried by wagons but a short distance before the cost of transportation would equal the value of the load.

The desired reduction of freight rates has not yet been accomplished; but the movement toward cheapness has been so pronounced that it is safe to predict that when railroads are using locomotives and cars of maximum power and capacity, a day's wages of a common laborer in New York may be sufficient to pay the charges on a year's food sent from St. Paul, Omaha, or Kansas City to New York. In 1887 the average charge for transporting a bushel of wheat from Chicago to New York by rail was 15.75 cents; in 1899 the charge was 11.6 cents. During the year 1887 the average rate per 100 pounds of meat from Cincinnati to New York by rail was 27.12 cents; during 1899 it was 24.83 cents.

Anterior to the steel-rail period, when wood-burning locomotives hauled cars loaded with from 500 to 600 bushels of wheat or from 15,000 to 20,000 pounds of other products, the rail freight charges for long distances were practically prohibitory. In 1858 the rate per bushel of wheat from Chicago to New York was 38.61 cents, and there was a very small margin of profit for the carriers. The introduction of more powerful locomotives and cars of greater capacity, together with water competition, pushed the all-rail rate downward till in 1870 it was 26.11 cents. At this time the lake and rail rate was 19.58 cents per bushel of wheat.

DEVELOPMENT WEST AND SOUTHWEST.

There were now prospects that land in districts remote from water carriage would be cultivated with profit to the farmer, and the tide of immigration flowed rapidly into States that previously had a meager population. In the decade from 1860 to 1870 twelve States and Territories in the West, Northwest, and Southwest added the following approximate increase of population:

Increase of population from 1860 to 1870.

State or Territory.	Increase of population from 1860 to 1870.	State or Territory.	Increase of population from 1860 to 1870.
Dakota	9,000	Minnesota	268,000
Illinois	728,000	Missouri	539,000
Indiana	330,000	Nebraska	94,000
Iowa	519,000	Texas	214,000
Kansas	257,000	Wisconsin	279,000
Kentucky	165,000		
Michigan	435,000	Total	3,837,000

This movement of immigration must have been greatly obstructed by the civil war, which covered nearly half of the decade. After peace and order were restored, the stream of immigration increased rapidly.

The increase of agricultural products was closely related to the increase of population. Cheap railroad rates enabled the more remote farmers to compete with farmers raising farm produce on the seacoast, and their dressed meat and grain were sent to consumers thousands of miles away. The subject of ocean transportation as relating to the distribution of the agricultural products in this country and the creation of a world market for them has been treated of fully in another publication issued by the Department.[1] The subject

[1] Statistics of Freight Charges for Ocean Transportation of the Products of Agriculture, October 1, 1895, to October 1, 1896, prepared by Mr. H. T. Newcomb, formerly chief of the section of freight rates, Division of Statistics, Department of Agriculture, now chief of the division of agriculture, Twelfth Census.

of canal transportation is a large one, and will only be mentioned in this paper, especially since the subject has been exhaustively treated of in other publications.[1]

FREIGHT AND PASSENGER RATES.

FREIGHT RATES.[2]

The following table shows the freight rates, in cents, per bushel for wheat and corn from Chicago to New York:

Rates, in cents, per bushel for wheat and corn from Chicago to New York, 1870, 1880, 1890, and 1899.

Year.	Wheat.		Corn.	
	By rail.	By rail and water.	By rail.	By rail and water.
	Cents.	*Cents.*	*Cents.*	*Cents.*
1870	26.11	19.58	24.37	19.32
1880	19.8	15.8	17.48	14.43
1890	14.3	8.52	11.36	7.32
1899	11.6	6.63	10.08	5.83

The tendency of rates for live stock and dressed meat has been steadily downward, but not in the same proportion as the rates for cereals.

The following are the rates, in cents, per 100 pounds of live stock from Chicago to New York by rail:

Rates, in cents, per 100 pounds of live stock from Chicago to New York by rail, 1872, 1880, 1890, 1895, and 1899.

Year.	Cattle.	Hogs.	Sheep.	Horses and mules.	Dressed beef.	Dressed hogs.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1872					81	
1880	55	43	65	60	88	
1890	23	28	30	60	39	39
1895	28	30	30	60	45	45
1899	25	25	25	60	40	40

The distance from St. Louis to New Orleans by rail is about 754 miles. By water it is considerably greater. The river rates, however, compare favorably with the charges by rail. In 1866 corn and rye per bushel cost 9.05 cents during high water and 10.93 during low water. In 1877 these rates were 7.63 and 8.59 cents, respectively, and

[1] See Publications of the American Economic Association, Vol. V, 1890, Nos. 3 and 4, two papers on the canal question, by Edmund J. James, Ph. D., and by Lewis M. Haupt, C. E.; also Quarterly Journal of Economics, February, 1900, "The New York canals," by John A. Fairlie.

[2] All rates are expressed in gold.

grain in sacks of 100 pounds cost 20.04 cents for freight, while wheat in bulk was charged only 8.11 cents per bushel. In 1899 these latter rates had dropped to 10 and 4.50 cents, respectively. The rates for corn and rye were quoted in 1892 as 5 cents per bushel for high water and 7 cents for low water.

The distance from Cincinnati to New York is about 200 miles shorter than the distance from Chicago, but the rates for dressed meats are not materially lower. In 1868 the average rate per 100 pounds was 48.8 cents. In 1880 the rate was 33.41 cents; in 1890 it was 23.89 cents, and in 1899 it was 24.83 cents.

For bulky, fragile, and perishable articles higher rates are charged by railroad companies than for those heavy articles with which a car can be loaded to its full carrying capacity as measured by weight, and which are not likely to sustain damage in transit. The following table shows the rates, in cents, for 100 pounds of a variety of merchandise from New York to Chicago:

Rates, in cents, per 100 pounds of merchandise from New York to Chicago by rail, 1867, 1870, 1880, 1890, and 1899.

Year.	Less than car load.			Regardless of quantity.				
	Agricultural implements.	Lead.	Sugar.	Dry goods.	Cotton piece goods.	Boots and shoes.	Tea.	Drugs.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1867	137	60	60	137	137	137	135	137
1870	113	61	....	113	113	113	113	113
1880	....	40	40	75	75	75	65	75
1890	50	35	35	75	50	75	75	75
1899	50	35	35	75	50	75	75	75

Car loads naturally come cheaper than small quantities, but it was only the later generations of railroad officials who recognized this distinction. They have also treated shippers of different classes of freight more equitably than their predecessors. The following are the rates, in cents, per 100 pounds of a variety of commodities from New York to Chicago by rail, in car loads:

Rates, in cents, per 100 pounds of articles from New York to Chicago by rail, 1867, 1870, 1880, 1890, and 1899.

Year.	Furniture.	Agricultural implements.	Crockery and earthenware.	Coffee.	Starch.	Molasses.	Soap.	
							Castile.	Common.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1867	137	137	117	117	117	60	117	93
1870	113	113	....	....	78	....	98	60
1880	75	40	40	40	40	40	60	40
1890	65	30	30	25	25	30	65	30
1899	65	30	30	25	25	30	25	25

The following are the average freight rates, in cents, per ton per mile charged by different railroad companies:

Average rates, in cents, per ton per mile by different railroads, 1867, 1870, 1880, 1890, and 1898.

Year.	Boston and Albany.	New York Central.	Erie.	Lake Shore and Michigan Southern.	Pennsylvania.	Chesapeake and Ohio.	Chicago, Rock Island and Pacific.	Illinois Central.	Union Pacific.	All in United States.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1867	2.201	1.98	1.465	1.745	1.497	3.753	2.185	2.085	--------	1.925
1870	1.851	1.590	1.125	1.269	1.268	4.101	2.316	1.953	3.596	1.889
1880	1.207	.879	.836	.750	.918	.866	1.209	1.543	--------	1.232
1890	1.105	.730	.665	.644	.661	.561	.995	.942	1.138	.941
1898	.839	.606	.575	.530	.521	.369	.966	.695	.95	.753

PASSENGER RATES.

The following table shows the average rates, in cents, per passenger-mile charged by different railroad companies:

Average rates, in cents, per passenger-mile, 1867, 1870, 1880, 1890, and 1898.

Year.	Boston and Albany.	New York Central.	Erie.	Lake Shore and Michigan Southern.	Pennsylvania.	Chesapeake and Ohio.	Chicago, Rock Island and Pacific.	Illinois Central.	Union Pacific.	All in United States.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1867	1.955	--------	1.641	--------	2.074	--------	3.132	2.798	--------	1.994
1870	2.342	1.77	2.47	2.204	2.167	3.979	3.426	3.29	4.301	2.392
1880	2.096	1.999	2.041	2.135	2.222	2.959	2.806	2.514	--------	3.442
1890	1.858	1.91	1.584	2.253	2.094	2.056	2.149	2.022	2.045	2.167
1898	1.75	1.806	1.548	2.032	1.953	1.943	2.092	1.938	1.945	1.973

It will be seen from the above figures that the downward trend of passenger rates has not been conspicuous. Indeed, the above table shows that passenger rates were about as high in 1898 as they were in 1867. There is so much suburban business, which is carried at reduced rates, mixed up with the figures quoted that the real rates for through travel are higher than the table shows. As the rates on American passenger trains for first-class cars have been for forty years as low as were to be found in any country, it is not surprising that they have undergone little reduction.[1]

[1] For a detailed statement of railway transportation rates, see Bulletin No. 15, miscellaneous series, Division of Statistics, U. S. Department of Agriculture, Changes in the Rates of Charge for Railway and other Transportation Services, prepared under the direction of Mr. John Hyde, Statistician, by Mr. H. T. Newcomb, formerly chief of the section of freight rates.

The Midland Railway of England, which may be taken as a representative road, some years ago abolished second-class passenger rates, and now runs only first-class and third-class carriages. The rate for first class is $3\frac{1}{6}$ cents per mile, and for third class 2 cents per mile. Other railways charge from $4\frac{1}{2}$ cents to 5 cents per mile for first class, 3 to $3\frac{1}{2}$ cents for second class, and 2 cents per mile for third class, the latter rate being regulated by law.

Mr. George H. Daniels, general passenger agent of the New York Central Railroad, a high authority on railroad matters, in an address delivered before the Utica Chamber of Commerce on February 19, 1900, said:

> It is beyond question that American railroads to-day furnish the best service in the world, at the lowest rates of fare, at the same time paying their employees very much higher wages than are paid for similar service in any other country on the globe.
>
> In the United States the first-class passenger fares last year averaged 1.98 cents per mile, although on some large railways the average was several mills less than 2 cents per mile; in England the first-class fare is 4 cents per mile; third-class fare, for vastly inferior service, is 2 cents per mile, but only on certain parliamentary trains.
>
> In Prussia the first-class fare is 3 cents per mile; in Austria 3.05 cents per mile; in France 3.36 cents per mile.
>
> Our passenger cars excel those of foreign countries in all that goes to make up the comfort and convenience of a journey.
>
> Our sleeping and parlor car system is vastly superior to theirs; our baggage system is infinitely better than theirs, and arranged upon a much more liberal basis. American railroads carry 150 pounds of baggage free, while the German roads carry only 55 pounds free.
>
> The lighting of our trains is superb, while the lighting of trains on most foreign lines is wretched.

The annual reports of British railway companies do not show the charges of freight per mile, but Mr. E. G. Dorsey, a well-known civil engineer, investigated the subject several years ago, and his conclusion was that the rates averaged $2\frac{1}{2}$ cents per ton per mile. That is nearly three times the average rate charged by American railroads. Mr. J. S. Jeans, secretary of the Iron and Steel Institute of Great Britain, estimates the average rate for mineral to be 1.5 cents per ton per mile. The rates on railways on the Continent of Europe are a little higher than those of England for both freight and passengers.

APPENDIX.

SUMMARY OF INFORMATION ON VARIOUS SUBJECTS OF INTEREST TO THE FARMER.

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APPENDIX.

ORGANIZATION OF THE DEPARTMENT OF AGRICULTURE, DECEMBER 31, 1899.

OFFICE OF THE SECRETARY.

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*, Tooie A. Geddes; *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*, Henry S. Graves.

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*, O. F. Cook.

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*, B. T. Galloway; *Assistant Pathologist*, Albert F. Woods.

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*, Thomas A. Williams.

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.—*Acting 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.

DIVISION OF GARDENS AND GROUNDS.—*Horticulturist and Superintendent of Gardens and Grounds*, William Saunders.

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.

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, 1898, 1899, AND 1900.

Object of appropriation.	1898.	1899.	1900.
Salaries, Department of Agriculture	$319,300	$319,300	$336,340
Furniture, cases, and repairs, Department of Agriculture	9,000	9,000	10,000
Library, Department of Agriculture	7,000	6,000	5,000
Museum, Department of Agriculture	3,000	1,500	1,500
Postage, Department of Agriculture	3,000	2,000	2,000
Contingent expenses, Department of Agriculture	25,000	25,000	25,000
Animal quarantine stations	12,000	12,000	12,000
Collecting agricultural statistics	110,000	105,000	110,000
Botanical investigations and experiments	15,000	20,000	20,000
Entomological investigations	20,000	20,000	20,000
Vegetable pathological investigations	20,000	20,000	26,000
Biological investigations	17,500	17,500	17,500
Pomological investigations	8,000	9,500	9,500
Laboratory, Department of Agriculture	12,400	12,400	17,700
Forestry investigations	20,000	20,000	40,000
Experimental gardens and grounds, Department of Agriculture	25,000	20,000	28,000
Soil investigations[1]	10,000	10,000	20,000
Grass and forage plant investigations	10,000	10,000	12,000
Fiber investigations	5,000	----------	----------
Agricultural experiment stations [$755,000, 1898; $760,000, 1899; $765,000, 1900][1]	35,000	40,000	45,000
Nutrition investigations	15,000	15,000	15,000
Public-road inquiries	8,000	8,000	8,000
Publications, Department of Agriculture	65,000	65,000	80,000
Sugar investigations	5,000	7,000	7,000
Purchase and distribution of valuable seeds	130,000	130,000	130,000
Salaries and expenses, Bureau of Animal Industry	675,000	900,000	950,000
Irrigation information	----------	10,000	35,000
Tea-culture investigations	----------	----------	1,000
Total	1,584,200	1,814,200	1,983,540
Weather Bureau.			
Salaries, Weather Bureau	150,540	153,340	153,320
Fuel, lights, and repairs, Weather Bureau	8,000	8,000	8,000
Contingent expenses, Weather Bureau	8,000	8,000	8,000
General expenses, Weather Bureau	717,162	765,162	768,162
Meteorological observation stations	----------	75,000	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 Western Bureau building, Washington	----------	----------	25,000
Total for Weather Bureau	883,702	1,015,502	1,022,482
Grand total	2,467,902	2,829,702	3,006,022

[1] Of these amounts $720,000 is annually paid directly to the experiment stations by the United States Treasury.

AGRICULTURAL COLLEGES AND OTHER INSTITUTIONS IN THE UNITED STATES HAVING COURSES IN AGRICULTURE.[1]

State or Territory.	Name of institution.	Location.	President.
Alabama	State Agricultural and Mechanical College (Alabama Polytechnic Institute).	Auburn	W. L. Broun, M. A., LL. D.
	State Normal and Industrial School.	Normal	W. H. Councill, Ph. D.
Arizona	University of Arizona	Tucson	M. M. Parker, M. A.
Arkansas	Arkansas Industrial University.	Fayetteville	J. L. Buchanan, M. A., LL. D.
	Branch Normal College	Pine Bluff	J. C. Corbin.
California	University of California	Berkeley	B. I. Wheeler, Ph. D., LL. D.
Colorado	The State Agricultural College of Colorado.	Fort Collins	B. O. Aylesworth, M. A., LL. D.
Connecticut	Storrs Agricultural College	Storrs	G. W. Flint, M. A.
Delaware	Delaware College	Newark	G. A. Harter, M. A., 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.
	Georgia State Industrial College.	College	R. R. Wright.
Idaho	University of Idaho	Moscow	J. P. Blanton, M. A., LL. D.
Illinois	University of Illinois	Urbana	A. S. Draper, LL. D.
Indiana	Purdue University	Lafayette	
Iowa	Iowa State College of Agriculture and Mechanic Arts.	Ames	W. M. Beardshear, M. A., LL. D.
Kansas	Kansas State Agricultural College.	Manhattan	E. R. Nichols, M. A.
Kentucky	Agricultural and Mechanical College of Kentucky.	Lexington	J. K. Patterson, Ph. D., LL. D.
	State Normal School for Colored Persons.	Frankfort	J. E. Givens, B. A.
Louisiana	Louisiana State University and Agricultural and Mechanical College.	Baton Rouge	T. D. Boyd, M. A., LL. D.
	Southern University and Agricultural and Mechanical College.	New Orleans	H. A. Hill.
Maine	The University of Maine	Orono	A. W. Harris, D. Sc.
Maryland	Maryland Agricultural College.	College Park	R. W. Silvester.
Massachusetts	Massachusetts Agricultural College.	Amherst	H. H. Goodell, LL. D.
	Massachusetts Institute of Technology.	Boston	Henry S. Pritchett.
Michigan	Michigan State Agricultural College.	Agricultural College.	J. L. Snyder, M. A., Ph. D.
Minnesota	The University of Minnesota	Minneapolis	C. Northrop, LL. D.
Mississippi	Mississippi Agricultural and Mechanical College.	Agricultural College.	
	Alcorn Agricultural and Mechanical College.	Westside	W. H. Lanier, B. A.
Missouri	School of Agriculture and Engineering of the University of Missouri.	Columbia	R. H. Jesse, LL. D.
	School of Mines and Metallurgy of the University of Missouri.	Rolla	R. H. Jesse, LL. D.
	Lincoln Institute	Jefferson City	J. H. Jackson, B. A., M. A.
Montana	The Montana College of Agriculture and Mechanic Arts.	Bozeman	J. Reid, A. B.
Nebraska	The University of Nebraska	Lincoln	C. E. Bessey, Ph. D., LL. D.
Nevada	Nevada State University	Reno	J. E. Stubbs, M. A., D. D., LL. D.
New Hampshire	The New Hampshire College of Agriculture and the Mechanic Arts.	Durham	C. S. Murkland, M. A., Ph. D.
New Jersey	Rutgers Scientific School (The New Jersey State College for the Benefit of Agriculture and the Mechanic Arts).	New Brunswick	Austin Scott, Ph. D., 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, M. A., D. Sc., LL. D.

[1] Including only institutions established under the land-grant act of July 2, 1862.

AGRICULTURAL COLLEGES AND OTHER INSTITUTIONS, ETC.—Continued.

State or Territory	Name of institution.	Location.	President.
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.
Oregon	Oregon State Agricultural College.	Corvallis	T. M. Gatch, M. A., Ph. D.
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, Ph. D., LL.D.
Tennessee	University of Tennessee	Knoxville	C.W. Dabney, Ph. D., LL.D.
Texas	State Agricultural and Mechanical College of Texas.	College Station	L. L. Foster.
	Prairie View State Normal School.	Prairieview	L. C. Anderson, M. A.
Utah	The Agricultural College of Utah.	Logan	
Vermont	University of Vermont and State Agricultural College.	Burlington	M. H. Buckham, D. D.
Virginia	Virginia Polytechnic Institute (State Agricultural and Mechanical College).	Blacksburg	J. M. McBryde, Ph. D., 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	4		Soil improvement; field experiments; horticulture; floriculture; diseases of plants; diseases of animals.
Arizona, Tuscon: R. H. Forbes	9	3	Chemistry; field experiments; meteorology; diseases of plants; horticulture (including date-palm orchard).
Arkansas, Fayetteville: R. L. Bennett	8	4	Chemistry of foods; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals.

AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES, ETC.—Continued.

Stations, locations, and directors.	Number on staff.	Number of teachers on staff.	Principal lines of work.
California, Berkeley: E. W. Hilgard	30	11	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	17	8	Chemistry; botany; meteorology; field experiments; horticulture; entomology; irrigation.
Connecticut (State), New Haven: E. H. Jenkins	15	....	Analysis and inspection of fertilizers, foods, and feeding stuffs; chemistry; diseases of plants; horticulture; field experiments; entomology.
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; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology; dairying.
Florida, Lake City: W. F. Yocum	9	5	Chemistry; field experiments; horticulture; entomology.
Georgia, Experiment: R. J. Redding	8	1	Field experiments; horticulture; entomology; mycology; pig feeding; dairying.
Idaho, Moscow: J. P. Blanton	11	10	Physics; chemistry; 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	9	Chemistry; pot and field experiments; horticulture; feeding experiments; diseases of plants and animals.
Iowa, Ames: C. F. Curtiss	23	13	Chemistry; bacteriology; field experiments; horticulture; diseases of plants; feeding experiments; entomology; dairying.
Kansas, Manhattan: J. T. Willard	14	14	Soils; horticulture; seed breeding; field experiments; feeding and digestion experiments; diseases of animals; entomology.
Kentucky, Lexington: M. A. Scovell	10	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	23	6	Chemistry; geology; botany; bacteriology; soils; field experiments; horticulture; feeding experiments; entomology.
Louisiana (North), Calhoun: William C. Stubbs	....	....	Chemistry; soils; fertilizers; field experiments; horticulture; stock raising; dairying.
Maine, Orono: C. D. Woods	13	6	Chemistry; botany; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; 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	7	Chemistry; soils; field experiments; horticulture; diseases of plants; feeding experiments; entomology.

AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES, ETC.—Continued.

Stations, locations, and directors.	Number on staff.	Number of teachers on staff.	Principal lines of work.
Massachusetts, Amherst: H. H. Goodell	22	9	Chemistry; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; field experiments; horticulture; diseases of plants; digestion and feeding experiments; diseases of animals; entomology.
Michigan, Agricultural College: C. D. Smith	16	9	Botany and bacteriology; field experiments; horticulture; forestry; diseases of plants; feeding experiments; diseases of animals; entomology; dairying.
Minnesota, St. Anthony Park, St. Paul: W. M. Liggett	14	7	Chemistry; 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	12	4	Chemistry; soils; field experiments; horticulture; feeding experiments; dairying.
Missouri, Columbia: H. J. Waters	13	5	Chemistry; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology; drainage.
Montana, Bozeman: S. M. Emery	7	6	Field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; irrigation.
Nebraska, Lincoln: T. L. Lyon	19	10	Chemistry; botany; meteorology; field experiments; horticulture; forestry; feeding and breeding experiments; diseases of animals; entomology; irrigation.
Nevada, Reno: J. E. Stubbs	8	4	Chemistry; botany; soils; field experiments; horticulture; forestry; entomology; irrigation.
New Hampshire, Durham: C. S. Murkland	14	8	Chemistry; soil physics; field experiments; horticulture; diseases of plants; feeding experiments; entomology; dairying; road experiments.
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	14	8	Chemistry; botany; field experiments; horticulture; diseases of plants; entomology; irrigation.
New York (State), Geneva: W. H. Jordan	24	--------	Chemistry; bacteriology; meteorology; analysis and control of fertilizers; field experiments; horticulture; diseases of plants; feeding experiments; poultry experiments; dairying.
New York (Cornell), Ithaca: I. P. Roberts	21	8	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	12	8	Chemistry; field experiments; horticulture; analysis of feeding stuffs; digestion experiments; poultry experiments.
North Dakota, Agricultural College: J. H. Worst	12	6	Field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; dairying.
Ohio, Wooster: C. E. Thorne	13	--------	Soils; field experiments; horticulture; diseases of plants; breeding and feeding experiments; entomology.

AGRICULTURAL EXPERIMENT STATIONS OF THE UNITED STATES, ETC.—Continued.

Stations, locations, and directors.	Number on staff.	Number of teachers on staff.	Principal lines of work.
Oklahoma, Stillwater: John T. Fields	10	5	Botany; field experiments; horticulture; diseases of plants; digestion and feeding experiments; diseases of animals; entomology.
Oregon, Corvallis: T. M. Gatch	12	12	Chemistry; soils; field crops; horticulture; diseases of plants; digestion and feeding experiments; entomology; dairying.
Pennsylvania, State College: H. P. Armsby	18	7	Chemistry; meteorology; fertilizer analysis; field experiments; feeding experiments; dairying.
Rhode Island, Kingston: A. A. Brigham	12	4	Chemistry; meteorology; soils; field and pot experiments; horticulture; diseases of plants; poultry experiments; oyster culture.
South Carolina, Clemson College: H. S. Hartzog	13	8	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	11	6	Bacteriology; chemistry of soils and soil physics; field experiments; forestry; diseases of plants; feeding experiments; entomology; irrigation.
Tennessee, Knoxville: C. W. Dabney	12	3	Chemistry; botany; fertilizers; field experiments; horticulture; animal production; entomology; dairying.
Texas, College Station: J. H. Connell	15	7	Chemistry; soils; fertilizers; field experiments; horticulture; feeding dairy cows; sheep husbandry; diseases of animals; irrigation.
Utah, Logan: L. Foster	11	8	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.
Vermont, Burlington: J. L. Hills	12	5	Chemistry; analysis and control of fertilizers and feeding stuffs; field experiments; horticulture; disease of plants; feeding experiments; diseases of animals; dairying.
Virginia, Blacksburg: J. M. McBryde	10	6	Chemistry; fertilizers; diseases of plants; feeding experiments; diseases of animals; entomology.
Washington, Pullman: E. A. Bryan	11	9	Chemistry; soils; bacteriology; field experiments; horticulture; diseases of plants; feeding experiments; entomology.
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	20	....	Chemistry; soils; field experiments; horticulture; feeding experiments; diseases of animals; dairying; drainage and irrigation.
Wyoming, Laramie: E. E. Smiley	8	5	Geology; botany; meteorology; waters; soils; fertilizers; field experiments; food analysis; feeding experiments; entomology.

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, 1899, TO DECEMBER 31, 1899.

The following publications were issued by the United States Department of Agriculture during the year January 1, 1899, to December 31, 1899. 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.

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Spraying Fruits for Insect Pests and Fungous Diseases, with a Special Consideration of the subject in Relation to the Public Health. Farm. Bul. 7. Reprint	500
The Rape Plant: Its History, Culture, and Uses. Farm. Bul. 11. Reprint	500
The Hawaiian Islands. Reprinted from Yearbook for 1898	2,000
The Present Condition of Grape Culture in California. Reprinted from Yearbook for 1898	500
Temperature Changes in Fermenting Piles of Cigar-Leaf Tobacco. Rept. 60	5,000
Tea culture. The Experiment in South Carolina. Report 61. 10 cents	5,000
Cultivation of Cigar-Leaf Tobacco in Florida. Report 62. 10 cents	6,000

CONGRESSIONAL PUBLICATIONS.

Fifteenth Annual Report of the Bureau of Animal Industry, for the Fiscal Year 1898. 75 cents	30,500
Annual Reports of the Department of Agriculture for the Fiscal Year ended June 30, 1898	3,000
Letter from the Secretary of Agriculture, transmitting a detailed statement of the expenditures of all the appropriations in the Department of Agriculture for the fiscal year ending June 30, 1898, including supplemental accounts to date. House Doc. No. 23, 55th Cong., 3d sess	1,722
Operations of the Bureau of Animal Industry for the Fiscal Year ended June 30, 1898. Senate Doc. No. 55, 55th Cong., 3d sess	1,722
Special Report on the Market for American Horses in Foreign Countries	20,000
A Report on the Work and Expenditures of the Agricultural Experiment Stations for the Year ended June 30, 1898	1,722
A second Report to Congress on Agriculture in Alaska, Including Reports by C. C. Georgeson and Walter H. Evans, prepared under the direction of A. C. True, Director of the Office of Experiment Stations	1,722
Usefulness of Reservoirs to Agriculture in the Irrigated Regions. Response of Secretary of Agriculture to Senate Resolution of February 8, 1899. Senate Doc. No. 124, 55th Cong., 3d sess	3,000
Report of the Chief of the Weather Bureau, 1897–98. In 7 parts. Part I, Administrative report. Parts II, III, IV, V, and VI, Climatology of the Year. Part VII, Climate of Cuba and Miscellaneous Papers	4,000
Yearbook of the U. S. Department of Agriculture, 1898. 60 cents	500,000
Progress of the Beet-Sugar Industry in the United States in 1898. Part I, by Charles F. Saylor, Special Agent. Part II, by H. W. Wiley, Chemist of the U. S. Department of Agriculture	50,000
Report upon the Forestry Investigations of the U. S. Department of Agriculture, 1877–1898. House Doc. No. 181, 55th Cong., 3d sess	1,734

DIVISION OF AGROSTOLOGY.

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Notes on Some English Farms and Farmers. Reprinted from Yearbook for 1898	200
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[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.

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	A. J. Cook, Conductor Farmers' Institutes for Southern California.	Claremont.
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	A. T. Neale (Director Agricultural Experiment Station), Superintendent Farmers' Institute for Newcastle County.	Newark.
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[Organized January 25, 1898.]

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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, H. T. French, Moscow, Idaho.

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California Dairy Association.—Secretary, Samuel E. Watson, 421 Market Street, San Francisco.

Dairymen's Association of Southern California.—Secretary, James R. Boal, 126 West Twenty-fifth street, Los Angeles.

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Connecticut Creamery Association.—Secretary, Frank Avery, Manchester.

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Georgia Dairymen's Association.—Secretary, M. L. Duggan, Sparta.

ILLINOIS.

Food Commissioner.—Commissioner, Alfred M. 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 La Salle street, Chicago.

INDIANA.

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MAINE.

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MASSACHUSETTS.

Dairy Bureau.—Assistant executive officer, George M. Whitaker, Box 1332, Boston.

Massachusetts Creamery Association.—Secretary, A. W. Morse, Belchertown.

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Ohio State Dairymen's Association.—Secretary, L. P. Bailey, Tacoma.
Ohio Dairy Union.—Secretary, F. A. Stranahan, 30 Huron street, Cleveland.

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Creamery Association of Eastern Pennsylvania.—Secretary, George R. Meloney, 1937 Market street, Philadelphia.

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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: 34,936; date of first entry, November, 1883. Registration fees: For animals under 1 year old, to members, $1.50; nonmembers, $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[2] 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.[3]

American Galloway Breeders' Association.—Frank B. Hearne, Independence, Mo., secretary. Number of registrations: 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., secre-

[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] 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.

[3] 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.

tary. Number of registrations: Bulls, 6,369; cows, 12.331; 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 Herd Book, 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: 90,000; 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. Transfers within 6 months of sale free to members, 25 cents to nonmembers; after 6 months, 50 cents to all. Duplicate certificates, 25 cents. 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: 204,006; 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, Mexico, Ind., secretary.

American Shorthorn Breeders' Association.—J. H. Pickrell, Springfield, Ill., secretary. Number of registrations: Over 400,000; date of first herdbook, 1846. Registration fees: For all animals under 4 years, $1 each; over 4 years, $25 each; 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, 6,928; cows, 15,505; 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 Herdbook of Scotland. Eligible to registry: Animals that trace closely 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: 3,100; 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, 383; females, 904; 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: 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, 6,753; cows, 14,419; 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 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, 15½ hands high; imported, 15 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, 1,524; 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, 9,440, 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, $2; nonmembers owning these books, $3; members not owning books, $3; nonmembers not owning books, $5. Transfers for members, $1; nonmembers, $2. 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 48, Astor Court Building, West Thirty-fourth street, New York City, secretary. Number of registrations: Stallions, 527; mares, 1,043; mares inspected and recorded, 117. Registration fees: Members' stallions, $3; members' mares, $2; nonmembers, double. Transfers for 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 society: English Hackney Horse Society, London, England.

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, 5,460; 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, 21,320. 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 registration: 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, 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, 10,137; association organized February 9, 1876. Registration fees: To members, $2, nonmembers, $4; for transfer, $1 to members, $2 to nonmembers. If application is not made within one year from importation or foaling the registration fee is $5. 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.—Charles Irwin, 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; also to 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, 1,400; mares, 1,721; date of first entry, July 31, 1891. Registration fees: To members, $2; nonmembers, $4; if registered during the year foaled, one-half. Affiliated foreign society: None. Eligible 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, 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.

National Cheviot Sheep Society.—Howard H. Keim, Ladoga, Ind., secretary. Number of registrations, 1,292; 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 21,000. 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: 3,812; 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.

American Lincoln Breeders' Association.—L. C. Graham, Cameron, Ill., secretary.

American Merino Sheep Register.—R. O. Logan, California, Mich., secretary.

American Oxford-Down Record Association.—W. A. Shafor, Middletown, Ohio, secretary. Number of registrations: 17,829; 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: Not stated. Eligible to registry: Animals imported from Europe if registered in the English flock book: native animals when approved by the board of directors.

American Southdown Association.—J. G. Springer, Springfield, Ill., secretary. Number of registrations: 12,977; date of first entry, May 4, 1883. Registration fees: To members, for animals up to July 1 following birth, 50 cents; older, $1.50; to nonmembers, 50 cents additional. Transfers 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: 10,000; 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 50 cents to all. Eligible to registry: Proof of pure blood satisfactory to committee.

American Suffolk Association.—F. A. Franklin, Atlantic, Iowa, secretary.

Black Top Spanish Merino Sheep Breeders' Association.—R. P. Berry, Clokey, Pa., secretary.

Delaine Merino Sheep Breeders' Association.—J. C. McNary, Houstonville, Pa., recording secretary; J. H. Hamilton, Cannonsburg, Pa., corresponding secretary.

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: 1,000; date of first entry, June 23, 1891. Registration fees: Certificates, 50 cents: transfers, 25 cents. Affiliated foreign society: Not stated.

Hampshire-Down Breeders' Association of America.—J. I. Gordon, Mercer, Pa., secretary. Number of registrations: 8,712: 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.—R. B. Barber, Cedarville, 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. 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. Daniels, Elva, Mich., secretary. Number of registrations: 6,873; 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, 20 cents; for entered pedigree, 40 cents; for recording stock ram in list, $1; 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 Lake, N. Y., secretary.

The Continental Dorset Club.—J. E. Wing, Mechanicsburg, Ohio, secretary. Number of registrations: 716 in 1898 and 523 in 1899; 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, 10 cents. Affiliated foreign society: None. 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, Enon Valley, Pa., secretary.

Vermont Atwood Club Register.—George Hammond, Middlebury, Vt., secretary.

Vermont Merino Sheep Breeders' Association.—L. H. Skiff, Middlebury, Vt., secretary.

SWINE BREEDERS' ASSOCIATIONS.

American Berkshire Association.—C. F. Mills, 512 East Monroe street, Springfield, Ill., secretary. Number of registrations: 52,500; date of first entry, 1875. Registration fees: For native animals under 2 years, $1; over 2 years, $2; imported animals, within 6 months of importation, $1; after 6 months, $2. Transfers, 25 cents; certificates, 50 cents. Affiliated foreign society: Not stated. Eligible to registry: Animals that trace closely to ancestors recorded in the book of the association.

American Duroc-Jersey Swine Breeders' Association.—A. V. Bradrick, Shelbyville, Ind., secretary. Number of registrations: 9,480 females, 4,048 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, 1,685; sows, 2,632; 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., secret tary. Number of registrations: 2,810.

Chester White Record Association.—W. H. Morris, Indianapolis, Ind., secretary.

American Chester White Record Association.—Carl Freigau, Dayton, Ohio, secretary. Number of registrations: Boars, 3,105; sows, 3,890; date of first entry, October, 1884. Registration fees: To members, 50 cents for each animal; nonmembers, $1; transfers, 25 cents. Affiliated 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 Swine Association.—W. H. Morris, Indianapolis, Ind., secretary.

Ohio Poland-China Record Company.—Carl Freigau, Dayton, Ohio, secretary. Number of registrations: Boars, 24,432; sows, 58,980; 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: 79,688; 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, 3,250; females, 7,500; 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: 521; 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 the affiliated English book.

The American Yorkshire Club.—William F. Wilcox, Benson, Minn., secretary.

ASSOCIATION OF BREEDERS OF DOGS.

American Kennel Club.—A. P. Vredenburg, 55 Liberty street, New York, N. Y., secretary.

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	A. P. Schwab	Rochester, N. Y.
Cornish Indian Game Club of America	Adam Thompson	Amity, Mo.
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 st., 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 Bldg., Tacoma, Wash.
Western Bantam Breeders' Association	A. E. Brown	Morgan Park, Ill.

POULTRY ASSOCIATIONS—Continued.

Secretaries of State poultry associations.

State.	Secretary.	Post office.
District of Columbia	Geo. E. Howard	Washington.
Illinois	Edward Craig	Albion.
Michigan	John A. Grover	Concord.
Oklahoma	L. F. Laverty	Guthrie.
Rhode Island	H. S. Babcock	Providence.
Tennessee	M. D. Andes	Bristol.

STATE VETERINARIANS AND SECRETARIES OF SANITARY BOARDS.

ALABAMA.

Dr. Jerome Cochran, Montgomery, secretary State board of health.

ARIZONA.

H. Harrison, Phenix, secretary live-stock sanitary commission.
Dr. J. C. Norton, Phenix, veterinarian.

CALIFORNIA.

Dr. J. R. Lanie, 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. Henry Sewall, 23 Eighteenth avenue, Denver, secretary State board of health.
Dr. Solomon Bock, Denver, State veterinary surgeon.

CONNECTICUT.

Dr. C. A. Lindsley, New Haven, secretary State board of health.
George L. Fosket, Winsted, secretary of commissioners on diseases of domestic animals.

DELAWARE.

Dr. E. B. Frazer, Wilmington, secretary State board of health.

FLORIDA.

Dr. Joseph Y. Porter, Key West, secretary State board of health.

ILLINOIS.

Dr. J. W. Scott, 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. H. Z. Gill, Topeka, secretary State board of health.
Taylor Riddle, Marion, secretary live-stock sanitary commission.

KENTUCKY.

Dr. J. N. McCormack, Bowling Green, secretary State board of health.
Dr. F. T. Eisenman, Louisville, State veterinarian.
A. G. Herr, St. Matthews, cattle commissioner.

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.
John M. Deering, Saco, and F. O. Beal, Bangor, cattle commissioners.

MARYLAND.

Dr. John S. Fulton, 10 South street, Baltimore, secretary State board of health.
Dr. A. W. Clements, 916 Cathedral street, Baltimore, State veterinarian.
C. W. Melville, Westminster, secretary live-stock sanitary board.

MASSACHUSETTS.

Dr. Samuel W. Abbott, Boston, secretary State board of health.
Dr. Austin Peters, Boston (Commonwealth Building), president cattle commissioners.

MICHIGAN.

Dr. Henry B. Baker, Lansing, secretary State board of health.
Dr. George W. Dunphy, Quincy, State veterinarian.
Henry H. Hinds, Stanton, 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. B. F. Luckey, Columbia, State veterinarian.
J. R. Rippey, 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.
Dr. Cooper Curtice, Raleigh, consulting veterinarian, State board 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.
Dr. J. W. Scheiber, 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.

Dr. J. H. Hamilton, Richford, secretary board of health.
C. J. Bell, East Hardwick, secretary cattle commission.

VIRGINIA.

Dr. Paulus A. Irving, Richmond, secretary board of health.
Dr. Charles McCulloch, 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.
D. M. Sullivan, Charleston, secretary board of agriculture.

WISCONSIN.

Dr. H. P. Clute, Milton, 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.

CENTRAL COMMITTEE, NATIONAL ROAD PARLIAMENT.[1]

State or Territory.	Committeemen.	Post office.
Alabama	Maj. W. W. Screws	Montgomery.
Alaska	Governor John G. Brady	Sitka.
Arizona	Governor L. C. Hughes	Tucson.
Arkansas	G. W. Sappington	Little Rock.
California	J. A. Woodson	Sacramento.
Colorado	Louis G. Carpenter	Fort Collins.
Connecticut	Col. Chas. L. Burdett	Hartford.
Delaware	William Cooch	Newark.
District of Columbia	Gen. Roy Stone, acting president of league	Washington.
Florida	J. W. White	Jacksonville.
Georgia	Col. G. W. Harrison	Atlanta.
Idaho	James Mullany	Glenns Ferry.
Illinois	S. T. K. Prime, general western secretary of league.	Dwight.
do	W. C. Garrard	Springfield.
Indiana	Mason J. Niblack	Vincennes.
Iowa	E. H. Thayer, chairman conference committee.	Clinton.

[1] These persons are also the co-workers of Office of Public Road Inquiries, Department of Agriculture. They are supplied with the publications of that office as issued, and in return furnish information of progress in road making in their respective States.

CENTRAL COMMITTEE, NATIONAL ROAD PARLIAMENT—Continued.

State or Territory.	Committeemen.	Post office.
Kansas	F. D. Coburn	Topeka.
Kentucky	Maj. M. H. Crump	Bowling Green.
Louisiana	Guy Samuels	Baton Rouge.
Maine	F. J. Ilsley	Portland.
Maryland	D. C. Wharton Smith	Darlington.
Massachusetts	George A. Perkins	Boston.
Michigan	W. L. Webber	Saginaw, East Side.
Minnesota	A. B. Choate	Minneapolis.
Mississippi	Capt. James H. Duke	Scooba.
Missouri	John R. Rippey	Columbia.
Montana	F. H. Ray	Helena.
Nebraska	Curtis Turner	Omaha.
Nevada	Gen. John E. Jones	Carson City.
New Hampshire	Ex-Governor David H. Goodell	Antrim.
New Jersey	E. G. Harrison, general eastern secretary of league.	Asbury Park.
New Mexico	E. S. Stover	Albuquerque.
New York	J. A. C. Wright	Rochester.
North Carolina	John C. Tipton	Shelby.
North Dakota	W. W. Barrett	Churchs Ferry.
Ohio	Hon. Martin Dodge	Cleveland.
Oklahoma	A. N. Spencer	Yukon.
Oregon	Jefferson Myers	Salem.
Rhode Island	C. H. Handy	Warren.
South Carolina	W. D. Evans	Bennettsville.
South Dakota	O. S. Basford	Redfield.
Tennessee	Maj. C. A. Locke	Nashville.
Texas	J. S. Dougherty	Dallas.
Vermont	J. W. Votey	Burlington.
Virginia	Thomas Whitehead	Richmond.
Washington	J. Hannum Jones	Nooksack.
Wisconsin	Otto Dorner, general press agent of league	Milwaukee
Wyoming	C. P. Hill	Cheyenne.

STATES HAVING OFFICES FOR FOREST WORK.

Kansas.—Forest commissioner, E. D. Wheeler, Ogallah.

Maine.—Forest commissioner, Charles E. Oak, Augusta.

Michigan.—Forest commission, Arthur Hill, president, Saginaw.

Minnesota.—Fire warden, Gen. C. C. Andrews, St. Paul.

New Hampshire.—Forest commission, George H. Moses, secretary, Concord.

New Jersey.—Geological survey, Prof. John C. Smock, director, Trenton.

New York.—Fisheries, game, and forest commission, Austin W. Wadsworth, president, Albany.

North Carolina.—Geological survey, Prof. J. A. Holmes, director, Chapelhill.

North Dakota.—State superintendent of irrigation and forestry, W. W. Barrett, Bismarck.

Pennsylvania.—Forest commissioner, Dr. J. T. Rothrock, chief, Harrisburg.

Wisconsin.—Forest commission, Ernest Bruncken, secretary, Milwaukee.

West Virginia.—Geologic and economic survey, Dr. I. C. White, superintendent, Morgantown.

FORESTRY ASSOCIATIONS.

American Forestry Association.—President, James Wilson, Secretary of Agriculture; secretary, F. H. Newell, United States Geological Survey, Washington, D. C.

California Society for Conserving the Waters and Forests.—President, Hon. J. M. Gleaves; secretary, E. H. Benjamin.

Sierra Club.—President, John Muir, Martinez, Cal.; secretary (corresponding), Prof. W. R. Dudley, Stanford University, Cal.

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.

Colorado Forestry Association.—President, W. N. Byers, Denver; secretary, D. W. Working, Denver.

Connecticut Forestry Association.—President, Maj. Edward V. Preston, Travelers' Insurance Company, Hartford; secretary (corresponding), Miss Mary Winslow, Weatogue.

Indiana Forestry Association.—President, A. Lieber, Indianapolis; secretary, J. P. Brown, Connersville.

Massachusetts Forestry Association.—President, Henry P. Walcott, Cambridge; secretary, Allen Chamberlain, Tremont Building, Boston.

Minnesota State Forestry Association.—President, W. W. Prendergast, Hutchison; secretary, George W. Strand, Taylors Falls.

New Jersey Forestry Association.—President, S. Bayard Dod, Hoboken; secretary-treasurer, J. F. Hall, Atlantic City.

North Carolina Forestry Association.—President, W. E. Petty, Seaboard Air Line; secretary, W. W. Ashe, Chapelhill.

North Dakota, The Sylvaton Society.—W. W. Barrett, Bismarck.

Mazamas, The.—President, W. G. Steel, Portland, Oreg.; secretary, Frank E. Donaldson, 264 Stark street, Portland.

Pennsylvania Forestry Association.—President, John Birkinbine, 1012 Walnut street, Philadelphia; secretary, Dr. Joseph T. Rothrock, commissioner of forestry, Harrisburg; corresponding secretary, Mrs. John P. Lundy, 245 South Eighteenth street, Philadelphia.

Franklin Forestry Society, The.—President, Alvin B. Kuhn; secretary, W. G. Bowers, Chambersburg, Pa.

Chester County, S. C., The Forestry Association of.—President, Judge J. J. McClure; secretary and treasurer, Prof. H. A. Green, Chester.

Utah Forestry Association.—President, Dr. J. R. Park; secretary, Prof. C. A. Whiting, Salt Lake City.

Washington Forestry Association.—President, Prof. Edmund S. Meany, Seattle; secretary, Albert Bryan.

SCHOOLS OF 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.

Colorado.—The State Agricultural College of Colorado, Fort Collins: Portion of junior term in horticulture.

Connecticut.—Yale Forest School: A two years' graduate course.

Storrs Agricultural College, Storrs: Touched on in horticultural course.

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.

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 instruction.

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 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: Two terms, twenty exercises each; general instruction.

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.

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.

The North Carolina College of Agriculture and Mechanic Arts, West Raleigh: One term, one hour a week; lectures only.

North Carolina State University, Chapel Hill: 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; attention 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.

AMERICAN ASSOCIATION OF NURSERYMEN, 1900.

President, W. J. Peters, Troy, Ohio; vice-president, E. Albertson, Bridgeport, Ind.; secretary, George C. Seager, Rochester, N. Y.; treasurer, C. L. Yates, Rochester, N. Y.

AMERICAN CARNATION SOCIETY, 1900.

President, William P. Craig, Philadelphia, Pa.; vice-president, William F. Kastings, Buffalo, N. Y.; secretary, Albert M. Herr, Lancaster, Pa.; treasurer, Fred Dorner, jr., Lafayette, Ind.

AMERICAN CRANBERRY GROWERS' ASSOCIATION, 1900.

President, E. H. Durell, Woodbury, N. J.; first vice-president, Joshua S. Wills, Medford, N. J.; second vice-president, C. L. Holman, Toms River, N. J.; secretary and treasurer, A. J. Rider, Trenton, N. J.

AMERICAN POMOLOGICAL SOCIETY, 1899-1900.

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.

AMERICAN ROSE SOCIETY, 1900.

President, Benjamin Dorrance, Dorrancetown, Pa.; 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, 1900.

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 Miltenberger, No. 213 North Second street, St. Louis, Mo.

EASTERN NURSERYMEN'S ASSOCIATION, 1900.

President, W. C. Barry, Rochester, N. Y.; vice-president, R. G. Chase, Geneva, N. Y.; secretary and treasurer, William Pitkin, Rochester, N. Y.

MISSOURI VALLEY HORTICULTURAL SOCIETY, 1900.

President, Homer Reed, Tenth and Broadway, Kansas City, Mo.; vice-president, Edwin Taylor, Edwardsville, Kans.; secretary, A. Chandler, Argentine, Kans.; treasurer, G. F. Espenlaub, Rosedale, Kans.

NORTHWEST FRUIT GROWERS' ASSOCIATION, 1900.

President, Dr. N. G. Blalock, Wallawalla, Wash.; vice-presidents, L. A. Porter, Lewiston, Idaho; E. L. Smith, Hood River, Oreg.; Frank L. Wheeler, North Yakima, Wash.; E. Hutcheson, Landers, B. C.; secretary, H. E. Dosch, Portland, Oreg.; treasurer, W. S. Offner, Wallawalla, Wash.

PENINSULA HORTICULTURAL SOCIETY, 1900.

President, Joseph E. Carter, Smyrna, Del.; vice-president, Orlando Harrison, Berlin, Md.; secretary-treasurer, Wesley Webb, Dover, Del.

SOCIETY OF AMERICAN FLORISTS AND ORNAMENTAL HORTICULTURISTS, 1900.

President, Edmund M. Wood, Natick, Mass.; vice-president, F. R. Pierson, Tarrytown, N. Y.; secretary, William J. Stewart, Boston, Mass.; treasurer, H. B. Beatty, Oil City, Pa.

WESTERN ASSOCIATION OF WHOLESALE NURSERYMEN, 1900.

President, A. L. Brooke, North Topeka, Kans.; vice-president, R. H. Blair, Kansas City, Mo.; secretary and treasurer, U. B. Pearsall, Leavenworth, Kans.

STATE SOCIETIES.

Arkansas State Horticultural Society, 1900.—President S. H. Nowlin, Little Rock; vice-president, W. J. Patton, Springdale; secretary, W. K. Tipton, Little Rock; treasurer, Joseph Vestal, Little Rock.

California State Floral Society, 1900.—President, Emory E. Smith, Palo Alto; secretary, Mrs. H. P. Tricou, San Francisco.

Pomological Society of California, 1900.—President, Abbot Kinney, Los Angeles; vice-president, D. Edson Smith, Santa Ana; secretary and treasurer, G. H. A. Goodwin, Los Angeles.

Colorado State Horticultural Society, 1900.—President, W. S. Coburn, Hotchkiss; secretary, W. B. Osborn, Denver.

Connecticut Pomological Society, 1900.—President J. H. Merriman, New Britain; vice-president, G. S. Butler, Cromwell; secretary, H. C. C. Miles, Milford; treasurer, R. A. Moore, Kensington.

Florida State Horticultural Society, 1900.—President, G. L. Taber, Glen St. Mary; secretary, Stephen Powers, Jacksonville; treasurer, W. S. Hart, Hawks Park.

Georgia State Horticultural Society, 1900.—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, 1900.—President, Charles P. Hartley, Caldwell; vice-president, Robert Schleicher, Lewiston; secretary, Robert Milliken, Nampa; treasurer, G. T. Hamill, Nampa.

Illinois State Horticultural Society, 1900.—President, Henry M. Dunlap, Savoy; vice-president, H. A. Aldrich, Neoga; secretary, L. R. Bryant, Princeton; treasurer, J. W. Stanton, Richview.

Indiana Horticultural Society, 1900.—President, C. M. Hobbs, Bridgeport; secretary, James Troop, Lafayette; treasurer, Sylvester Johnson, Irvington.

Iowa State Horticultural Society, 1900.—President, Charles F. Gardner, Osage; vice-president, M. J. Wragg, Waukee; secretary, Wesley Greene, Des Moines; treasurer, W. M. Bomberger, Harlan.

Kansas State Horticultural Society, 1900.—President, Fred Wellhouse, Topeka; vice-president, J. W. Robison, Eldorado; secretary, William H. Barnes, Topeka; treasurer, Frank Holsinger, Rosedale; entomologist, Perry J. Parrott, Manhattan.

Kentucky State Horticultural Society, 1900.—President, M. F. Johnson, Fern Creek; secretary, J. C. Hawes, Fern Creek.

Maine State Pomological Society, 1900.—President, W. M. Munson, Orono; first vice-president, S. H. Dawes, Harrison; second vice-president, D. P. True, Leeds Center; secretary-treasurer, Charles S. Pope, Manchester.

Maryland State Horticultural Society, 1900.—President, James S. Harris, Coleman; vice-president, J. P. Blessing, Brownsville; secretary and treasurer, W. G. Johnson, College Park.

Massachusetts Fruit Growers' Association, 1900.—President, George Cruickshanks, Fitchburg; vice-president, H. O. Mead, Lunenburg; secretary; S. T. Maynard, Amherst; treasurer, Ethan Brooke, West Springfield.

Massachusetts Horticultural Society, 1900.—President, Francis H. Appleton, Boston; vice-president, Charles H. B. Breck, Boston; secretary, Robert Manning, 101 Tremont street, Boston; treasurer, Charles E. Richardson, 101 Tremont street, Boston.

Michigan State Horticultural Society, 1900.—President, C. J. Monroe, South Haven; vice-president, R. D. Graham, Grand Rapids; secretary, C. E. Bassett, Fennville; treasurer, Asa W. Slayton, Grand Rapids.

Minnesota State Horticultural Society, 1900.—President, W. W. Pendergast, Hutchison; vice-president, F. W. Kimball, Austin; secretary, A. W. Latham, 207 Kasota Block, Minneapolis; treasurer, H. M. Lyman, Excelsior.

Missouri State Horticultural Society, 1900.—President, N. F. Murray, Oregon; vice-president, D. A. Robnett, Columbia; secretary, L. A. Goodman, Westport; treasurer, A. Nelson, Lebanon.

Montana State Horticultural Society, 1900.—President, S. M. Emery, Bozeman; secretary and treasurer, C. H. Edwards, Missoula.

Nebraska State Horticultural Society, 1900.—President, George A. Marshall, Arlington; vice-president, J. H. Hadkinson, Omaha; secretary, C. H. Barnard, Table Rock; treasurer, Peter Youngers, jr., Geneva.

New Hampshire Horticultural Society, 1900.—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, 1900.—President, Henry E. Hale, Princeton; vice-president, William H. Reed, Tennent; secretary, Henry I. Budd, Mount Holly; treasurer, Charles L. Jones, Newark.

New Mexico Horticultural Society, 1900.—President, L. Bradford Prince, Santa Fe; vice-president, W. S. Harroun, Santa Fe; secretary, Jose D. Sena, Santa Fe; treasurer, Soloman Spiegelberg, Santa Fe.

North Carolina State Horticultural Society, 1900.—President, J. Van. Lindley, Pomona; vice-president, W. F. Massey, Raleigh; secretary and treasurer, Thomas L. Brown, Greensboro.

Ohio State Horticultural Society, 1900.—President, E. H. Cushman, Euclid; vice-president, W. N. Scarff, New Carlisle; secretary, W. W. Farnsworth, Waterville; treasurer, N. Ohmer, Dayton.

Oregon State Horticultural Society, 1900.—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 State Horticultural Association, 1900.—President, Howard A. Chase, 1430 South Penn Square, Philadelphia; vice-president, Daniel D. Herr, Lancaster; M. C. Dunlevy, Carnegie; recording secretary, E. B. Engle, Waynesboro; corresponding secretary, W. T. Brinton, Christiana; treasurer, Samuel C. Moon, Morrisville.

Pennsylvania Horticultural Society, 1900.—President, James M. Rhodes, Third and Chestnut streets, Philadelphia; vice-president, Robert Craig, Forty-ninth and Market streets, Philadelphia; secretary, David Rust, Horticultural Hall, Philadelphia; treasurer, Sidney W. Keith, Land Title Building, Philadelphia.

Rhode Island Horticultural Society, 1900.—President, J. E. C. Farnham, Providence; vice-presidents, R. H. I. Goddard, Providence, Royal C. Taft, Providence, Joseph D. Fitts, Providence; secretary and treasurer, Charles W. Smith, 61 Westminster street, Providence.

South Dakota State Horticultural Society, 1900.—President, H. C. Warner, Forestburg; vice-president, L. R. Alderman, Hurley; secretary, N. E. Hansen, Brookings; treasurer, G. H. Whiting, Yankton.

Texas State Horticultural Society, 1900.—President, F. T. Ramsey, Austin; vice-presidents, P. I. Burch, Rockport, S. D. Thompson, Bowie; secretary, Samuel H. Dixon, Pauli; treasurer, D. O. Lively, Fort Worth.

Vermont Horticultural Society, 1900.—President, T. L. Kinney, South Hero; secretary and treasurer, F. A. Waugh, Burlington.

Virginia State Horticultural Society, 1900.—President, Samuel B. Woods, Charlottesville; vice-president, A. F. Mosby, Richmond; recording secretary, George E. Murrell, Fontella; corresponding secretary and treasurer, Walter Whately, Crozet.

West Virginia State Horticultural Society, 1900.—President, R. C. Burkhart, Martinsburg; vice-president, J. H. Crawford, Organ Cave; secretary L. C. Corbett, Morgantown.

Wisconsin State Horticultural Society, 1900.—President, Franklin Johnson, Baraboo; vice-president, T. E. Loope, Eureka; secretary, J. L. Herbst, Sparta; treasurer, R. J. Coe, Fort Atkinson.

Wisconsin State Cranberry Growers' Association, 1900.—President, Charles Briers, Grand Rapids; vice-president, S. M. Whittlesey, Cranmoor; secretary, W. H. Fitch, Cranmoor; treasurer, Melvin Potter, Centralia.

OFFICERS AND MEMBERS OF STATE BOARDS OF HORTICULTURE.

California State Board of Horticulture, 1900.—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; clerk, E. F. Hallahan, Sacramento; district commissioners, Thomas A. Rice, H. Weinstock, Benjamin M. Maddox, A. Block, W. T. Hotchkiss.

Indiana State Board of Horticulture, 1900.—President, C. M. Hobbs, Bridgeport; vice-presidents, Mrs. W. W. Stevens, George P. Campbell, Amos Garretson, J. C. Grossman; secretary, J. Troop, Lafayette; treasurer, Sylvester Johnson, Irvington; executive committee, E. Y. Teas, L. B. Custer, J. C. Stevens.

Montana State Board of Horticulture, 1900.—President, I. D. O'Donnell, Billings; secretary, C. H. Edwards, Missoula; district committeemen, S. M. Emery, W. H. Campbell, D. E. Bandmann, J. H. Edwards; Governor R. B. Smith, ex officio, Helena.

Oregon State Board of Horticulture, 1900.—President, H. B. Miller; 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, 1900.—President, Thomas Judd; vice-president, H. E. Carey; secretary, J. A. Wright, Ogden.

LOCAL HORTICULTURAL SOCIETIES.

Horticultural Society of Central Illinois, 1900.—President, H. Augustine, Normal; vice-president, G. J. Foster, Bloomington; secretary, J. C. Blair, Champaign.

Horticultural Society of Northern Illinois, 1900.—President, J. L. Hartwell, Dixon; vice-president, O. W. Barnard, Manteno; secretary, A. W. Bryant, Princeton; treasurer, L. Woodard, Marengo.

Horticultural Society of Southern Illinois, 1900.—President, J. W. Stanton, Richview; vice-president, L. N. Beal, Mount Vernon; secretary and treasurer, E. G. Mendenhall, Kinmundy.

Northeastern Iowa Horticultural Society, 1900.—President, Charles F. Gardner, Osage; vice-president, Elmer Reeves, Waverly; secretary, Charles H. True, Edgewood; treasurer, G. A. Ivins, Iowa Falls.

Northwestern Iowa Horticultural Society, 1900.—President, P. F. Kinne, Storm Lake; vice-president, J. C. Winsett, Fostoria; treasurer, Ben Shoultz, Correctionville; secretary, W. B. Chapman, Washta.

Southeastern Iowa Horticultural Society, 1900.—President, W. S. Fultz, Muscatine; vice-president, W. T. Richey, Albia; secretary, C. W. Burton, Cedar Rapids; treasurer, F. R. Harrington, York Center.

Southwestern Iowa Horticultural Society, 1900.—President, J. P. Jackson, Glenwood; vice-president, Silas Wilson, Atlantic; secretary, W. M. Bomberger, Harlan; treasurer, I. M. Needles, Atlantic.

Horticultural Association of Western Maryland, 1900.—President, Charles C. Biggs, Sharpsburg; vice-president, Caleb Long, Downsville; secretary and treasurer, Arthur L. Towson, Smithsburg.

Cape Cod Cranberry Growers' Association, 1900.—President, Emulus Small, Harwick Port, Mass.; vice-president, Luther Hall, Dennis, Mass.; secretary and treasurer, Franklin Crocker, Hyannis.

West Michigan Horticultural Society, 1900.—President, R. M. Kellogg, Three Rivers; secretary, C. A. French, Grand Rapids; treasurer, A. Hamilton, Bangor.

Southern Minnesota Horticultural Society, 1900.—President, J. C. Hawkins, Austin; vice-presidents, O. L. Gregg, Austin, and O. W. Moore, Spring Valley; secretary and treasurer, Robert Parkhill, Chatfield.

Central Missouri Horticultural Association, 1900.—President, D. F. Nixon, Harriston; vice-president, D. Edwards, Boonville; secretary, C. C. Bell, Boonville; treasurer, W. A. Smiley, Boonville.

South Missouri Horticultural Association, 1900.—President, D. J. Nichols, West Plains; secretary and treasurer, J. T. Snodgrass, West Plains.

Eastern New York Horticultural Society, 1900.—President, James Wood, Mount Kisco; vice-president, W. F. Taber, Poughkeepsie; secretary and treasurer, Edwin C. Powell, Ghent.

Western New York Horticultural Society, 1900.—President, W. C. Barry, Rochester; vice-presidents, S. D. Willard, Geneva; J. S. Woodward, Lockport; Albert Wood, Carlton Station; T. B. Wilson, Halls Corners; secretary, John Hall, Rochester.

West Tennessee Horticultural Institute, 1900.—President, J. W. Rosaman, Gadsden; vice-president, L. C. James, Gibson; secretary and treasurer, J. D. Johnson, Henderson.

East Tennessee Horticultural Society.—President, E. F. Wetmore, Ogden; 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 Bee Keepers' Exchange.—Secretary, J. H. Martin, Riverside, Cal.

California State Bee Keepers' Association.—President, R. Wilkin, Ventura, Cal.; secretary, J. F. McIntyre, Sespe, Cal.

Central California Bee Keepers' Association.—Secretary, F. E. Brown, San Francisco.

COLORADO.

Colorado State Bee Keepers' Association.—President, R. C. Aikin, Loveland, Colo.; secretary, Frank Rauchfuss, Denver, Colo.

CONNECTICUT.

Connecticut Bee Keepers' Association.—Secretary, Mrs. W. C. Riley, Waterbury, Conn.

ILLINOIS.

Illinois State Bee Keepers' Association.—President, C. C. Miller, Marengo, Ill.; secretary, James A. Stone, Bradfordton, Ill.

Northern Illinois Bee Keepers' Association.—Secretary, B. Kennedy, New Milford, Ill.

INDIANA.

Indiana State Bee Keepers' Association.—President, E. S. Pope, Indianapolis, Ind.; secretary, W. S. Pouder, Indianapolis, Ind.

IOWA.

Eastern Iowa Bee Keepers' Association.—Secretary, W. A. Hay, Anamosa, Iowa.

KANSAS.

Southeastern Kansas Bee Keepers' Association.—President, J. P. Ralston, Uniontown, Kans.; secretary, J. C. Balch, Bronson, Kans.

MICHIGAN.

Michigan State Bee Keepers' Association.—President, George E. Hilton, Fremont, Mich.; secretary, William G. Voorheis, South Frankfort, Mich.

MINNESOTA.

Minnesota Bee Keepers' Association.—President, J. P. West, Hastings, Minn.; secretary, L. D. Leonard, Minneapolis, Minn.

Southern Minnesota Bee Keepers' Association.—President, E. B. Huffman, Homer, Minn.

NEBRASKA.

Nebraska Bee Keepers' Association.—President, E. Whitcomb, Friend, Nebr.; secretary, L. D. Stilson, York, Nebr.

NEW YORK.

New York State Association of Bee Keepers' Societies.—President, W. F. Marks, Chapinville, N. Y.; secretary-treasurer, C. B. Howard, Romulus, N. Y.

New York State Bee Keepers' Association.—President, I. L. Scofield, Chenango Bridge, N. Y.; secretary, J. H. Knickerbocker, Pleasant Valley, N. Y.

OHIO-PENNSYLVANIA.

Northeastern Ohio and Northwestern Pennsylvania Bee Keepers' Association.—Secretary, Ed Jolley, Franklin, Pa.

TENNESSEE.

Southern East Tennessee Bee Keepers' Association.—President, M. T. Fouts, Parksville, Tenn.; secretary, W. J. Copeland, Fetzerton, Tenn.

TEXAS.

Central Texas Bee Keepers' Association.—President, E. Y. Terral, Cameron, Tex.; secretary, E. R. Jones, Milano, Tex.

South Texas Bee Keepers' Association.—President, M. M. Faust, Floresville, Tex.; secretary, G. W. Huffstedler, Beeville, Tex.

Texas State Bee Keepers' Association.—President, W. R. Graham, Greenville, Tex.; secretary and treasurer, J. N. Hunter, Leonard, Tex.

UTAH.

Utah Bee Keepers' Association.—President, E. S. Lovesy, Salt Lake City, Utah; secretary and treasurer, J. B. Fagg, Mill Creek, Utah.

VERMONT.

Vermont Bee Keepers' Association.—Secretary, M. F. Cram, West Brookfield, Vt.

WASHINGTON.

Washington State Bee Keepers' Association.—Secretary, L. R. Freeman, North Yakima, Wash.

WISCONSIN.

Southwestern Wisconsin Bee Keepers' Association.—President, N. E. France, Platteville, Wis.; secretary, F. L. Murray, Calamine, Wis.

Wisconsin State Bee Keepers' Association.—Secretary, Miss Ada Pickard, Richland Center.

STATE OFFICIALS CONCERNED WITH THE PROTECTION OF BIRDS AND GAME.[1]

CALIFORNIA.

Board of fish commissioners.[2]

President, Alexander T. Vogelsang, Mills Building, San Francisco; Charles B. Gould, Oakland; H. W. Keller, Santa Monica; chief deputy, John P. Babcock, San Francisco.

COLORADO.

Department of game and fish.

Commissioner, Thos. H. Johnson, 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.

President, George T. Mathewson, Thompsonville; secretary, Alden Solmans, South Norwalk.

ILLINOIS.

State game commissioner.

Henry W. Loveday, Springfield; suboffice, 816 Schiller Building, Chicago.

INDIANA.

Commissioner of fisheries and game.

Z. T. Sweeney, Columbus.

IOWA.

Fish and game warden.

George E. Delavan, Estherville.

MAINE.

Commissioners of inland fisheries and game.

Chairman, L. T. Carleton, Augusta; Henry O. Stanley, Dixfield; Charles E. Oak, Caribou.

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[1] Corrected to April 1, 1900. [2] Has jurisdiction over matters relating to game.

MARYLAND.

Game warden.

Robert H. Gilbert, Calvert and Lombard streets, Baltimore.

MASSACHUSETTS.

Commissioners of fisheries and game.

Chairman, Joseph W. Collins, Boston; secretary, Edward A. Brackett, Winchester; Elisha D. Buffington, Worcester.

MICHIGAN.

Game and fish warden department.

Warden, Grant M. Morse, Portland; chief deputy, Charles E. Brewster, Portland.

MINNESOTA.

Fish and game commissioners.

President, A. T. Williams, Minneapolis; vice-president, Jacob Danz 2d, St. Paul; secretary, W. W. Ward, Fairmont; treasurer, A. L. Cramb, St. Cloud; executive agent, John Beutner, Proctorknott.

MISSOURI.

Game and fish warden.

A. J. D. Burford, Burfordville.

MONTANA.

Board of game and fish commissioners.

Chairman, Prof. M. J. Elrod, Missoula; secretary, R. A. Waagner, Bozeman; State warden, H. Percy Kennett, Victor.

NEW HAMPSHIRE.

Fish and game commission.

Chairman, N. Wentworth, Hudson Center; financial agent, W. H. Shurtleff, Lancaster; secretary, F. L. Hughes, Ashland.

NEW JERSEY.

Fish and game commissioners.

President and treasurer, Howard P. Frothingham, Mount Arlington; William A. Halsey, Newark; Benj. P. Morris, Long Branch; J. Frank Budd, Burlington City; fish and game protector, George Riley, 190 Broad street, Newark.

NEW YORK.

Commissioners of fisheries, game, and forests.

President, W. Austin Wadsworth, Livingston County; Percy Lansdowne, Buffalo, Erie County; Delos H. Mackey, Delaware County; B. Frank Wood, Queens County; De Witt C. Middleton, Watertown, Jefferson County; chief protector, J. Warren Pond, Albany.

NORTH DAKOTA.

Game warden.

Geo. E. Bowers, Fargo.

OHIO.

Commissioners of fish and game.

President, George Falloon, Athens; J. C. Burnett, Sabina; Albert Brewer, Tiffin; James W. Owens, Newark; A. J. Hazlett, Bucyrus; secretary and chief warden, L. H. Reutinger, Athens.

OREGON.

Game warden.

L. P. W. Quimby, Portland.

PENNSYLVANIA.

Board of game commissioners.

President, William M. Kennedy, Allegheny City; C. K. Sober, Lewisburg; James H. Worden, Harrisburg; E. B. Westfall, Williamsport; Dr. Charles B. Penrose, Philadelphia; I. A. Stearns, Wilkesbarre; secretary, Dr. Joseph Kalbfus, Harrisburg.

RHODE ISLAND.

Commissioners of birds.

Chairman, F. H. Peckham, jr., Providence County; E. R. Lewis, Washington County; William H. Thayer, Bristol County; A. O'D. Taylor, Newport County; secretary, Thomas W. Penney, Kent County.

UTAH.

Fish and game warden.

John Sharp, Salt Lake City.

VERMONT.

Fish and game commissioners.

John W. Titcomb, St. Johnsbury; Horace W. Bailey, Newbury.

WASHINGTON.

Fish commissioner and game warden.

A. C. Little, 210–212 Berlin Building, Tacoma.

WISCONSIN.

Fish and game warden

James T. Eliarson, Madison.

WYOMING.

Game warden.

Albert Nelson, Jackson.

MANITOBA.

Game guardian.

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.

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[1] Has jurisdiction over matters relating to protection of game.

NEWFOUNDLAND.

Department of marine and fisheries.[1]

Deputy minister, E. C. Watson, St. Johns; secretary, M. Harvey, St. Johns.

NOVA SCOTIA.

Nova Scotia Game and Inland Fishery Protection Society.

President, Col. Clerke; vice-presidents, H. N. Wallace, L. G. Power; secretary, Geo. Piers, Halifax; treasurer, H. N. Wallace; 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.

Game commission.

Chairman, Dr. G. A. MacCallum, Dunnville; James Dickson, Fenelon Falls; W. G. Parrish, Athens; W. B. Wells, Chatham; H. S. Osler, Toronto; chief game warden, E. Tinsley, Parliament Building, Toronto.

QUEBEC.

Department of lands, forests, and fisheries—Fisheries and game branch.

Commissioner, S. N. Parent; assistant commissioner, E. E. Paine; superintendent, L. Z. Joncas; general inspector and assistant superintendent, H. de Puyjalon, Quebec; provincial game keepers, N. E. Cormier, Aylmer East; Joseph Riendeau, Montreal.

NATIONAL ORGANIZATIONS FOR PROTECTION OF BIRDS AND GAME.

AMERICAN ORNITHOLOGISTS' UNION—COMMITTEE ON PROTECTION OF NORTH AMERICAN BIRDS.

Chairman, Witmer Stone, Academy Natural Sciences, Philadelphia, Pa.; E. H. Forbush, Malden, Mass.; William Dutcher, 525 Manhattan avenue, New York, N. Y.; Mrs. Olive Thorne Miller, 628 Hancock street, Brooklyn, N. Y.; Mrs. Edward Robins, 114 South Twenty-first street, Philadelphia, Pa.; Mrs. Florence Merriam Bailey, Washington, D. C.; T. S. Palmer, Department of Agriculture, Washington, D. C.; Ruthven Deane, 24 Michigan avenue, Chicago, Ill.; O. Widmann, Old Orchard, Mo.; Mrs. E. Irene Rood, Fort Worth, Tex.; Leverett M. Loomis, California Academy of Sciences, San Francisco, Cal.; A. W. Anthony, Taylorsville, Cal.; Mrs. Louise McGowen Stephenson, Helena, Ark.

LEAGUE OF AMERICAN SPORTSMEN.

President, G. O. Shields, 23 West Twenty-fourth street, New York, N. Y.
Secretary, Arthur F. Rice, 155 Pennington avenue, Passaic, N. J.
Treasurer, F. S. Hyatt, National Exchange Bank, 90 West Broadway, New York, N. Y.
Chief wardens of State divisions:
California—Dr. David Starr Jordan, Stanford University.
Colorado—A. Whitehead, 17 Bank Block, Denver.
Connecticut—Ralph B. Lawton, Bridgeport.
Illinois—H. W. Loveday, 816 Schiller Building, Chicago.
Massachusetts—Dr. Heber Bishop, 4 Post-Office square, Boston.
Michigan—J. Elmer Pratt, Grand Rapids.
Minnesota—S. A. Smart, St. Paul.
Montana—Prof. M. J. Elrod, Missoula.
New Jersey—A. W. Van Saun, Pompton Plains.
New York—A. E. Pond, 148 Fifth avenue, New York City.

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[1] Has jurisdiction over matters relating to protection of game.

Chief wardens of State divisions—Continued.
Ohio—L. H. Reutinger, Athens.
Oregon—Robert F. Kelly, Box 188, The Dalles.
Pennsylvania—C. F. Emerson, 189 North Perry street, Titusville.
Utah—John Sharp, Salt Lake City.
Vermont—W. E. Mack, Woodstock.
Virginia—Franklin Stearns, 13 North Eleventh street, Richmond.
Washington—J. S. Stangroom, New Whatcom.
Wisconsin—James T. Drought, Milwaukee.
Wyoming—Dr. Frank Dunham, Lander.

NATIONAL GAME, BIRD, AND FISH PROTECTIVE ASSOCIATION.

President, A. L. Lakey, Kalamazoo, Mich.
Secretary, C. E. Brewster, Grand Rapids, Mich.
Treasurer, J. P. Barnum, Prairie du Chien, Wis.

NATIONAL SPORTSMEN'S ASSOCIATION.

President, Charles Tatham, New York, N. Y.
Secretary-treasurer, J. A. H. Dressel, 280 Broadway, New York, N. Y.

NORTH AMERICAN FISH AND GAME PROTECTION ASSOCIATION.

President, S. N. Parent, Commissioner Lands, Forests, and Fisheries, Quebec,
Joint secretaries, L. Z. Joncas, Quebec; Rene Dupont, Quebec; D. J. Smith, Chatham, N. B.

STATE ORGANIZATIONS FOR PROTECTION OF BIRDS AND GAME.

ARKANSAS STATE SPORTSMEN'S ASSOCIATION.

President, W. A. Leach, Fort Smith.
Secretary, Paul R. Litzke, Little Rock.

CONNECTICUT ASSOCIATION OF FARMERS AND SPORTSMEN FOR THE PROTECTION OF FISH AND GAME.

President and treasurer, Abbott C. Collins, 18 Preston street, Hartford.
Secretary, George P. McLean, Simsbury.

DELAWARE GAME PROTECTIVE ASSOCIATION.

President, A. D. Poole, Wilmington.
Secretary and treasurer, I. N. Mills, Clayton.

GAME AND FISH PROTECTIVE ASSOCIATION, DISTRICT OF COLUMBIA.

President, Capt. Robley D. Evans, U. S. N.
Secretary, Dr. W. P. Young, 1333 F street NW., Washington.
Warden, Maj. Richard Sylvester, Washington.

ILLINOIS STATE SPORTSMEN'S ASSOCIATION.

President, E. S. Rice, Chicago.
Secretary-treasurer, Wm. B. Leffingwell, Room 1524 Masonic Temple, Chicago.

ILLINOIS FISH AND GAME PROTECTIVE ASSOCIATION.

President, H. W. Loveday, 816 Schiller Building, Chicago.
Secretary, H. A. Sullivan, Room 912, Ashland Block, Chicago.

IOWA STATE ASSOCIATION FOR THE PROTECTION OF FISH AND GAME.

President, W. B. Kibbey, Marshalltown.
Secretary, L. C. Abbott, Marshalltown.

KENTUCKY FIELD TRIAL CLUB.

President, Geo. L. Danforth, Louisville.
Secretary and treasurer, Herman Newcomb, Louisville.

KENTUCKY FISH AND GAME CLUB.

President, Frank Pragoff, 422 West Main street, Louisville.
Secretary, Hamilton Griswold, Louisville.

MARYLAND STATE GAME AND FISH PROTECTIVE ASSOCIATION.

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.

Chairman, A. B. F. Kinney, Worcester.
Secretary and treasurer, Henry H. Kimball, 5 Park square, Boston.

MASSACHUSETTS FISH AND GAME PROTECTIVE ASSOCIATION.

President, George W. Wiggin, Tremont Building, Boston.
Secretary and treasurer, Henry H. Kimball, 5 Park square, Boston.

ROD AND GUN CLUB OF MASSACHUSETTS.

President, C. P. Curtis, Boston.
Secretary and assistant treasurer, W. C. Thairlwall, 45 High street, Boston.

MICHIGAN STATE GAME AND FISH PROTECTIVE LEAGUE.

President, A. L. Lakey, Kalamazoo.
Secretary, C. E. Brewster, Grand Rapids.

NORTH DAKOTA STATE SPORTSMAN'S ASSOCIATION.

President, C. A. Hall, Grand Forks.
Secretary, E. C. Carruth, Grand Forks.

OREGON FISH AND GAME ASSOCIATION.

President, J. N. Teal, Portland.
Secretary, A. E. Gebhardt, Portland.

PENNSYLVANIA STATE SPORTSMEN'S ASSOCIATION.

President, J. O'H. Denny, Ligonier.
Secretary, Will K. Park, 34 South Third street, Philadelphia.

[SOUTH CAROLINA] WESTERN CAROLINA GAME PROTECTION ASSOCIATION.

President, C. F. Dill, Greenville.
Secretary and treasurer, Charles F. Schwing, Greenville.

TEXAS STATE SPORTSMEN'S ASSOCIATION.

President, B. S. Pillow, Austin.
Secretary and treasurer, Fred Petmecky, Austin.

UTAH STATE FISH AND GAME PROTECTIVE ASSOCIATION.

President, T. J. Almy, Salt Lake City.
Secretary, George D. Adler, Salt Lake City.

[VIRGINIA] EASTERN SHORE GAME PROTECTIVE ASSOCIATION.

President, J. W. Bowdoin, Bloxom.
Secretary and treasurer, T. W. Blackstone, Accomac, C. H.

VIRGINIA FIELD SPORTS ASSOCIATION.

President, Polk Miller, Richmond.
Secretary and treasurer, William H. Colquitt, Richmond.

FISH AND GAME PROTECTION CLUB, PROVINCE OF QUEBEC.

President, F. L. Wanklyn, Montreal.
Secretary, Wm. J. Cleghorn, 107 Board of Trade Building, Montreal.

AUDUBON SOCIETIES.

(Organized for the study and protection of birds.)

California:
President, Albert K. Smiley, Redlands.
Secretary, Mrs. George S. Gay, Redlands.

Connecticut:
President, Mrs. Mabel Osgood Wright, Fairfield.
Secretary, Mrs. William Brown Glover, Fairfield.

Delaware:
President, A. R. Spaid, 2311 West Eighteenth street, Wilmington.
Secretary, Mrs. Florence Bayard Hilles, Delaware place, Wilmington.

District of Columbia:
President, Gen. George M. Sternberg, U. S. A., Washington.
Secretary, Mrs. John Dewhurst Patten, 3033 P street, Washington.

Florida:
President, Rt. Rev. H. B. Whipple, Faribault, Minn.
Secretary, Mrs. C. F. Dommerich, Maitland, Fla.

Illinois:
President, Ruthven Deane, 30 Michigan avenue, Chicago.
Secretary, Miss Mary Drummond, Wheaton.

Indiana:
President, R. W. McBride.
Secretary, Amos W. Butler, Statehouse, Indianapolis.

Iowa:
President, Mrs. James B. Diver, Keokuk.
Secretary, Mrs. T. L. Wales, Keokuk.

Schaller [Iowa] Audubon Society:
President, Mrs. T. J. Andre, Schaller.
Secretary, Miss J. E. Hamand, Schaller.

Maryland:
President, Wm. C. A. Hammel, State Normal School, Baltimore.
Secretary, Miss Anne Weston Whitney, 715 St. Paul street, Baltimore.

Massachusetts:
President, William Brewster, Cambridge.
Secretary, Miss Harriet E. Richards, Society of Natural History, Boston.

Minnesota:
President, John W. Taylor, St. Paul.
Secretary, Mrs. J. P. Elmer, 314 West Third street, St. Paul.

New Hampshire:
President, Mrs. Arthur E. Clarke.
Secretary, Mrs. F. W. Batchelder, Manchester.

New Jersey:
President, Alexander Gilbert.
Secretary, Miss Anna Haviland, 53 Sandford avenue, Plainfield.

New York:
President, Morris K. Jesup, New York City.
Secretary, Miss Emma H. Lockwood, 243 West Seventy-fifth street, New York City.

Ohio:
President, William Hubbell Fisher, 13 Wiggins Block, Cincinnati.
Secretary, Mrs. D. Z. McClelland, 5265 Eastern avenue, Cincinnati.

Pennsylvania:
President, Witmer Stone, Academy Natural Sciences, Philadelphia.
Secretary, Mrs. Edward Robins, 114 South Twenty-first street, Philadelphia.

Rhode Island:
President, Prof. H. C. Bumpus, Providence.
Secretary, Mrs. H. T. Grant, jr., 187 Bowen street, Providence.

South Carolina:
President, Miss Christie H. Poppenheim, Charleston.
Secretary, Miss S. A. Smyth, Legare street, Charleston.

Tennessee:
President, P. T. Glass, Ripley.
Secretary, Mrs. C. C. Conner, Ripley.
Texas:
President, Mrs. J. W. Hertford.
Secretary, Miss Cecile Seixas, 2008 Thirty-ninth street, Galveston.
West Virginia (branch of Pennsylvania Society):
President, Witmer Stone, Academy Natural Sciences, Philadelphia, Pa.
Secretary, Elizabeth I. Cummins, 1314 Chapline street, Wheeling.
Wisconsin:
President, Edward A. Birge.
Secretary, Mrs. George W. Peckham, 646 Marshall street, Milwaukee.

FARMERS' READING COURSES.

Farmers' reading courses constitute one of the most important agents in the diffusion of knowledge among farmers and are rapidly growing in popularity. The idea of these reading courses is to systematize in a few definite lines the general home reading of the farmer, and to make the knowledge thus acquired a permanent mental endowment fund, to be used in making farm life more attractive and more profitable. The work is generally conducted on the Chautauqua plan. The agency having charge of it (usually the agricultural college) lays out certain courses of reading on such subjects as "soils and crops," "feeding and breeding of farm animals," "dairying," "fruit culture," "gardening," "farm economics," "domestic economy," and similar topics; selects sets of books for reading which most clearly set forth the principles underlying these subjects; provides for superintending the work; makes arrangements for supplying prospective readers with books, examination papers, etc.; and acts as a sort of bureau of information.

The method followed in any particular case is simple: A book on a chosen topic is sent to a reader, who is asked to read carefully a certain subject. Printed questions bearing on this subject are then sent to him and full answers, without recourse to the book, requested.

No expense is attached except for books and a small enrollment fee, seldom exceeding for the whole course more than $1 in amount. Sometimes diplomas signed by the college authorities are given upon the completion of a course. A course usually covers about two years' reading. Anyone wishing to take up the work of the reading course has but to apply for membership to the manager of the reading course in his own State, or in another State. Details regarding the courses offered, books required, enrollment fees, etc., will be sent him. Upon subscribing to the rules of the society, he is at once admitted as a member, and can begin reading without delay. No entrance examinations are required. Courses are provided for women and technical courses for special students.

The following is a list of States which have organized reading courses and of the officials in charge of these courses:

Connecticut	Prof. A. B. Peebles	Storrs.
Michigan	Prof. Clinton D. Smith	Agricultural College.
New Hampshire	Prof. C. W. Burkett	Durham.
New York	Prof. L. H. Bailey	Ithaca.
Pennsylvania	Prof. George C. Watson	State College.
South Dakota	Mr. S. A. Cochrane	Brookings.
West Virginia	Prof. T. C. Atkeson	Morgantown.

FARMERS' NATIONAL CONGRESS.

President, Hon. W. D. Hoard, Fort Atkinson, Wis.; secretary, John Stahl, No. 4328 Langley avenue, Chicago, Ill.

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 STATE GRANGES.

List of masters and other officers for 1900, so far as reported on April 1.

State.	Master.	Post office.	Lecturer.	Post office.	Treasurer.	Post office.	Secretary.	Post office.	Date of meeting.
Alabama	H. Hawkins	Hawkinsville	Rev. A. Daugherty.	Dothen	W. J. Roundtree.	Valegrande	F. Shackelford, jr.	Colquitt	Wednesday after second Monday in July.
California	G. W. Worthen	San Jose	John L. Beecher	Stockton	A. D. Logan	108 Davis street, San Francisco.	Miss L. S. Woodhams.	Santa Clara	First Tuesday in October.
Colorado	J. A. Newcomb	Golden	Wm. B. Roberts.	Boulder	W. W. Graves	Goberville	Will T. Wilson.	Niwot	Second Tuesday in January.
Connecticut	B. C. Patterson	Torrington	Frank S. Hopson.	Station 3, Bridgeport.	Norman S. Platt.	New Haven	H. E. Loomis	Glastonbury	Do.
Dakota *a*									
Delaware	Arnold Naudain, jr.	Stanton	A. T. Neale	Newark	Thos. H. Riggin.	Laurel	W. W. Seeders	Farmington	Second Tuesday in December.
Georgia	T. H. Kimbrough	Cataula	J. D. Gunnels	Banksville	S. H. Roberts.	Dawson	E. Taylor	Popes Ferry	Do.
Illinois	Oliver Wilson	Magnolia	E. H. Clarke	Dunlap	D. Q. Trotter	Piasa	Thos. Keady	Dunlap	Do.
Indiana	Aaron Jones	South Bend	W. W. Stevens.	Salem	J. W. Holmes	Cortland	Taylor B. Frazier.	Frankfort	Do.
Iowa	A. B. Judson	Silver City	Geo. Van Houden.	Lenox	W. H. Hollister	Manchester	John Turner	Lenox	Second Tuesday in October.
Kansas, including Oklahoma.	Henry Rhoades	Gardner	A. P. Reardon	McLouth	Wm. Henry	Olathe	Geo. Black	Olathe	Second Tuesday in December.
Kentucky	J. D. Clardy	Newstead	W. G. Myers	Wingo	J. M. Clark	Hopkinsville	J. A. Browning.	Church Hill	Do.
Maine	Obadiah Gardner	Rockland	Elijah Cook	Vassalboro	M. B. Hunt	Center Belmont.	E. H. Libby	Dirigo	Third Tuesday in December.
Maryland	Joseph B. Ager	Hyattsville	J. Enos Ray, sr.	Chillum	Geo. H. Merryman.	Bosley	Wm. B. Sands	Lake Roland	Second Tuesday in December.
Massachusetts	W. C. Jewett	Worcester	Geo. W. Ladd	Sturbridge	F. A. Harrington.	Worcester	Wm. N. Howard.	South Easton	Do.
Michigan	Geo. B. Horton	Fruitridge	Mrs. Frank Saunders.	Edgerton	E. A. Strong	Vicksburg	Miss Jennie Buell.	Ann Arbor	Do.
Minnesota	Mrs. S. G. Baird	Edina Mills	A. R. Hammargren.	Stark	Mrs. Corolin Schofield.	Bloomington	Mrs. A. J. Adams.	Box 447, Minneapolis.	Second Tuesday after December 4.
Mississippi	S. L. Wilson	Okolona	H. F. Simrall	Glass	Mrs. Joe Bailey.	Conehatta	T. J. Aby	Fayette	Second Tuesday in December.
Missouri	C. O. Raine	Benjamin	E. H. Long	Deerridge	W. E. Harbaugh.	Liberty	R. L. Harbaugh.	Liberty	Second Tuesday in October.
Nebraska	J. M. Williams	Culbertson	A. M. Bovee	Vacoma	B. S. Gitchel	Butler	J. R. Cantlin	Webster	Second Tuesday in December.
New Hampshire	N. J. Bachelder	Concord	Henry H. Metcalf.	Concord	J. D. Roberts	Salmon Falls	E. C. Hutchinson.	Milford	Third Tuesday in December.
New Jersey	Edmund Braddock.	Medford	George L. Gillingham.	Moorestown	C. Collins	Moorestown	M. D. Dickinson.	Woodstown	First Thursday in December.

New York	Elliot B. Norris	Sodus	F. P. Cole	Ovid	P. A. Welling	Hannibal	W. N. Giles	Skaneateles	First Tuesday in February.
North Carolina	W. R. Williams	Falkland	M. B. Pitt	Old Sparta	W. H. Powell	Battleboro	H. T. J. Ludwig.	Mount Pleasant.	Second Tuesday in December.
Ohio	S. H. Ellis	Waynesville	S. E. Strode	Westland	W. W. Miller	Columbus	Frank A. Akins.	Sandusky	Do.
Oregon, including Idaho.	W. M. Hilleary	Turner	S. H. Hatch	Turner	J. C. White	Crowley	Mrs. Mary S. Howard.	Mulino	Fourth Tuesday in May.
Pennsylvania	W. F. Hill	Westford	Wm. Packard	Windfall	S. E. Niven	Landenburg	J. T. Ailman	Thompsontown.	Second Tuesday in December.
Rhode Island	Joseph A. Tillinghast.	Kingston	P. H. Wilbur	Little Compton.	B. Martin	E. Providence.	N. T. Reynolds.	E. Greenwich.	Do.
South Carolina	W. K. Thompson	Liberty Hill	C. J. Rollins	Bishopville	H. Boykin	Ionia	W. A. James, jr.	Bishopville	First Tuesday in February.
Tennessee	W. L. Richardson.	Brownsville	J. M. McCorkle.	White Haven	D. A. Stewart	Brownsville	E. L. Allen	Brownsville	Third Tuesday in August.
Texas, including Indian Territory.	R. D. McGee	O'Daniel	J. C. Isbell	McGregor	J. L. Howell	Dublin	J. J. Ray	Dublin	Second Tuesday in August.
Vermont	C. J. Bell	E. Hardwick	R. B. Galusha	Jericho	F. B. Pier	Rawsonville	A. A. Priest	Randolph	Second Wednesday in December.
Virginia	A. J. Wedderburn.	Washington, D. C.	Thos. F. Rives.	Gunnshill	E. C. Powell	San Marino	T S Stadden	Wadesville	Second Tuesday in January.
Washington	Augustus High	Vancouver	Nicholas Ennis.	La Center	Wm. Smiley	Vancouver	F. C. Briggs	La Center	First Tuesday in June.
West Virginia	Prof. T. C. Atkeson.	Morgantown	Jas. George	Ashton	C. T. Perry	Cuba	M. V. Brown	Buffalo	Second Wednesday in January.
Wisconsin	H. E. Huxley	Neenah	S. C. Carr	Milton Junction.	George Harwood.	Chippewa Falls.	A. C. Powers	Beloit	Second Tuesday in December.

a Annexed to Minnesota; also Idaho is included with Oregon, Oklahoma with Kansas, and Indian Territory with Texas.

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 industrià y obras públicas, Santiago.

China.—No officer of central government. Provincial officers: His excellency the viceroy of Liang-Kiang, Nan-King. 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.—Mr. Alfred Hage, 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 Honorable 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'etat de l'agriculture, Port-au-Prince.

Italy.—Director-general of agriculture. etc. Official address: Direttore generale dell' agricoltura, industria e commercio, Roma.

Japan.—Mr. Arasuke Sone, minister of agriculture and commerce, Tokio.

Korea.—Mr. Ye Ching Kun, Seoul, Korea, minister of agriculture.

Mexico.—Señor Manuel Fernandez Leal, secretario de fomento, City of Mexico.

Nicaragua and Salvador.—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.—Director-general of agriculture, etc. Official address: Director-general de agricultura, industrià y comercio; Ministerio de Fomento, Madrid.

Sweden and Norway.—Count A. Wachtmeister. general direktö and chef för kongl. domänstyrelsen, Stockholm; M. M. Selmer, skogdirektor, Christiania.

Switzerland.—M. le conseiller fédéral, Dr. Adolphe Deucher, chef du departement fédéral du commerce, de l'industrie, et de l'agriculture, Palais Fédéral, Berne.

Turkey.—Selim Melhamé Pasha, Constantinople, minister of agriculture.

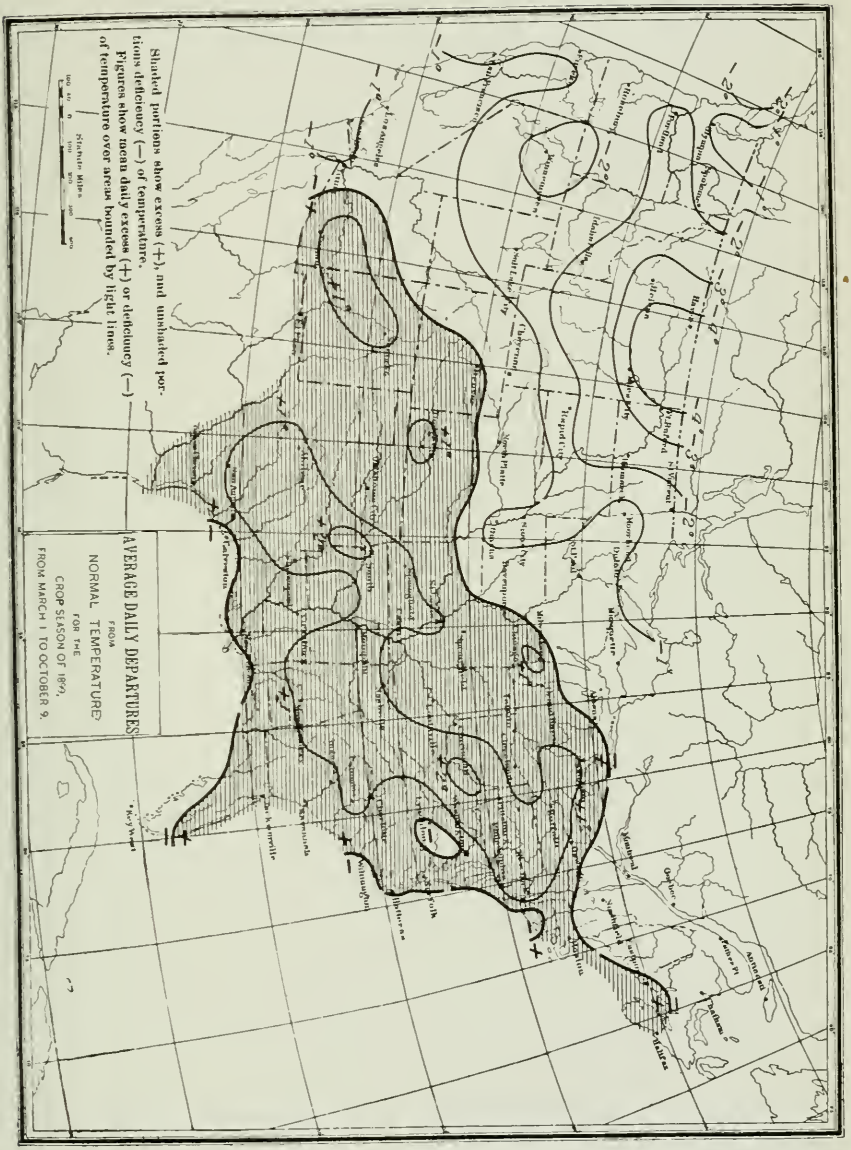
Venezuela.—Mr. Federico Fortique, dirección de agricultura y cria, Caracas.

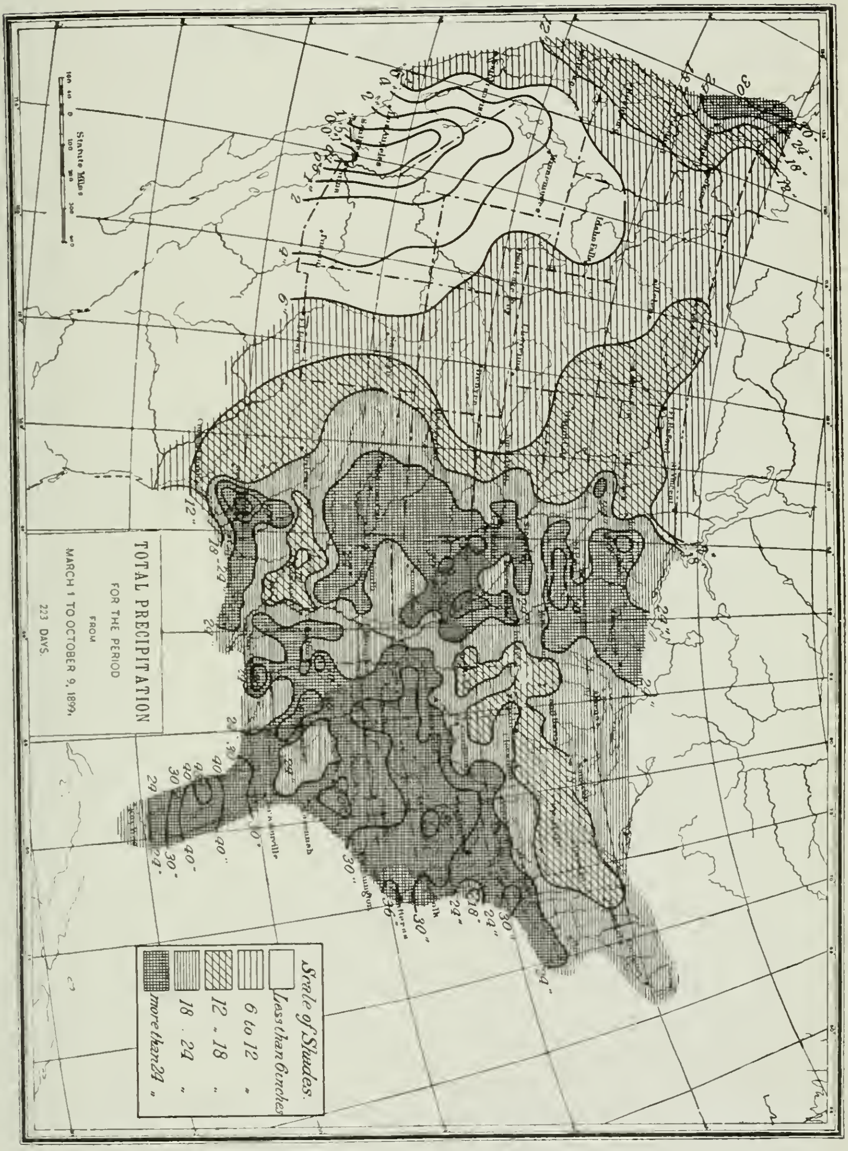
REVIEW OF WEATHER AND CROP CONDITIONS, SEASON OF 1899.

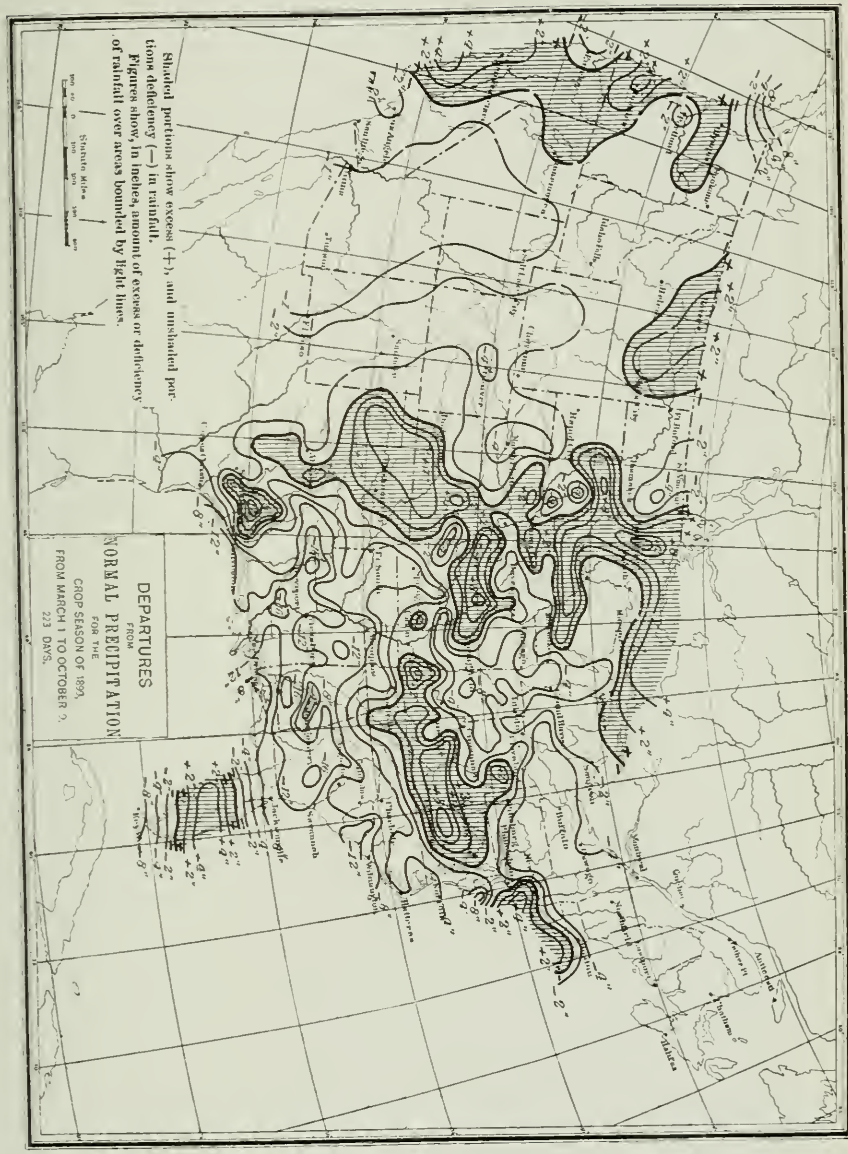
The accompanying tables and diagrams (see figs. 32 and 33 [pp. 722, 723] and Plates LXI–LXIII) show how the temperature and rainfall over the United States during the crop season of 1899 varied from week to week from normal conditions of corresponding periods of former years. The large tables show departures from normal temperature and precipitation (in degrees Fahrenheit and in inches and hundredths, respectively) for Weather Bureau stations, by months from January 1 to March 1, and by weeks ending Mondays at 8 a. m., seventy-fifth meridian time, from April 10 to October 9. The diagrams exhibit by curves the departures from normal, by districts, for the same period, and the three plates show, respectively, the departures from normal temperature and the total precipitation for the United States during the crop season and the departures from normal precipitation.

CONDITIONS FROM JANUARY TO APRIL.

In the Gulf States and interior portions of the Middle and South Atlantic States and over the southeastern Rocky Mountain slope, January was rather colder than the average, but the month was much milder than usual throughout the Ohio, Upper Mississippi, and Missouri valleys, northern and central Rocky Mountain region, and on the Pacific coast, the average temperature excess ranging from 6° to 9° per day from the central plateau region eastward to the Upper Missouri


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.
Statute Miles
AVERAGE DAILY DEPARTURES
FROM
NORMAL TEMPERATURE
FOR THE
CROP SEASON OF 1899,
FROM MARCH 1 TO OCTOBER 9.


TOTAL PRECIPITATION
FOR THE PERIOD
FROM
MARCH 1 TO OCTOBER 9, 1899.
223 DAYS.
Scale of Shades.
Less than 6 inches
6 to 12 "
12 - 18 "
18 - 24 "
more than 24 "
Statute Miles


DEPARTURES
FROM
NORMAL PRECIPITATION
FOR THE
CROP SEASON OF 1899,
223 DAYS.
Shaded portions show excess (+), and unshaded portions deficiency (—) in rainfall.
Figures show, in inches, amount of excess or deficiency of rainfall over areas bounded by light lines.
Statute Miles

Valley. There was much rain in the Southern States, particularly in the region from the west Gulf coast northeastward over Louisiana and portions of Mississippi, Tennessee, and Arkansas, where amounts ranging from 6 to more than 10 inches were reported. Throughout the Rocky Mountain districts, Upper Mississippi, and Missouri valleys, Lake region, and northern New England there was less than the usual precipitation, portions of Kansas, Nebraska, Iowa, and Missouri receiving less than .25 inch. Notwithstanding the fact that comparatively little protection was afforded winter wheat by snow covering, its general condition at the close of the month was promising. The crop was, however, subjected to a period of extreme cold in the latter part of January in the central valleys.

Except over portions of the middle Pacific coast region, where there was a slight excess in temperature, February was an exceptionally cold month throughout the United States. From the middle Atlantic coast westward to the eastern Rocky Mountain slope, and from the Gulf northward to the lake region, the average daily temperature deficiency generally ranged from 8° to 14°. There was much more than the average precipitation in the Atlantic coast districts south of New England, over portions of the central Rocky Mountain region, the greater part of Oregon, and along the immediate coast of Washington, while generally throughout the central valleys and lake region and from the central Gulf States westward to the south Pacific coast there was less than the usual amount, the month being exceptionally dry over nearly the whole of California, and thence eastward to Oklahoma and western Texas. During February the wheat crop experienced very unfavorable temperature conditions over a large part of the winter-wheat area, zero temperatures extending as far southward as central Texas and nearly to the eastern Gulf coast.

March averaged warmer than usual in the Gulf and Atlantic coast districts, but was very cold throughout the central valleys, Lake region, Rocky Mountain regions, and on the Pacific coast, the average daily deficiency in temperature from the Upper Mississippi Valley westward to Idaho ranging from 6° to more than 20°. Over the northern portions of Alabama, Georgia, and eastern Tennessee the precipitation was exceptionally heavy, and more than the average amount fell over the greater part of the Pacific coast, northern and central Rocky Mountain districts, and from the Upper Mississippi Valley eastward to the Atlantic coast. The month was drier than the average over the greater part of the Gulf States and in portions of the Missouri and Red River of the North valleys and on the north Pacific coast. At the close of the month the general condition of winter wheat was less favorable than at the end of February, except in Oregon and California, where the condition of the crop was promising. Preparations for cotton planting were well advanced in Texas, some having been planted in the southern part of that State, and in portions of Georgia and South Carolina. Corn planting had made some progress as far north as Tennessee, and in the more southerly sections a large part of the crop had been planted. The seeding of spring oats was in progress as far north as the Missouri and Ohio valleys.

SUMMARY OF THE SEASON BY WEEKS.

By weeks ending with Monday, from April 10 to September 25, the crop conditions may be summarized as follows:

April 10.—At this date the season was unusually late in all districts east of the Rocky Mountains, except over southern and western Texas. The ground was frozen to a considerable depth in the States of the Upper Missouri valley, frost being still in the ground as far south as northern Missouri, with considerable snow over portions of the upper Lake region and New England. From the middle Rocky Mountain slope eastward to the Atlantic coast the season was variously estimated to be from two to four weeks late, and as a result farming operations were much delayed. Some corn had been planted as far north as Tennessee and in the extreme southern portions of Missouri and Kansas, planting being nearly completed in Louisiana and Texas. Much cotton was planted in southern Texas, and some in northern Texas, but in the central and eastern portions of the cotton belt but little had been planted. The general condition of winter wheat continued unpromising in the principal wheat-producing States of the central valleys, but in California and Oregon the condition of this crop was very favorable. In Washington much wheat was winter-killed.

April 17.—The general weather conditions of this week were exceptionally favorable for farming operations and crops throughout the country, with the exception of the extreme north Pacific coast region, where the week was cold and wet, and over Arizona and the southern portions of California and Utah, where drought prevailed. Frost was leaving the ground rapidly in the States of the Upper Mississippi and Upper Missouri valleys, and considerable progress was made with

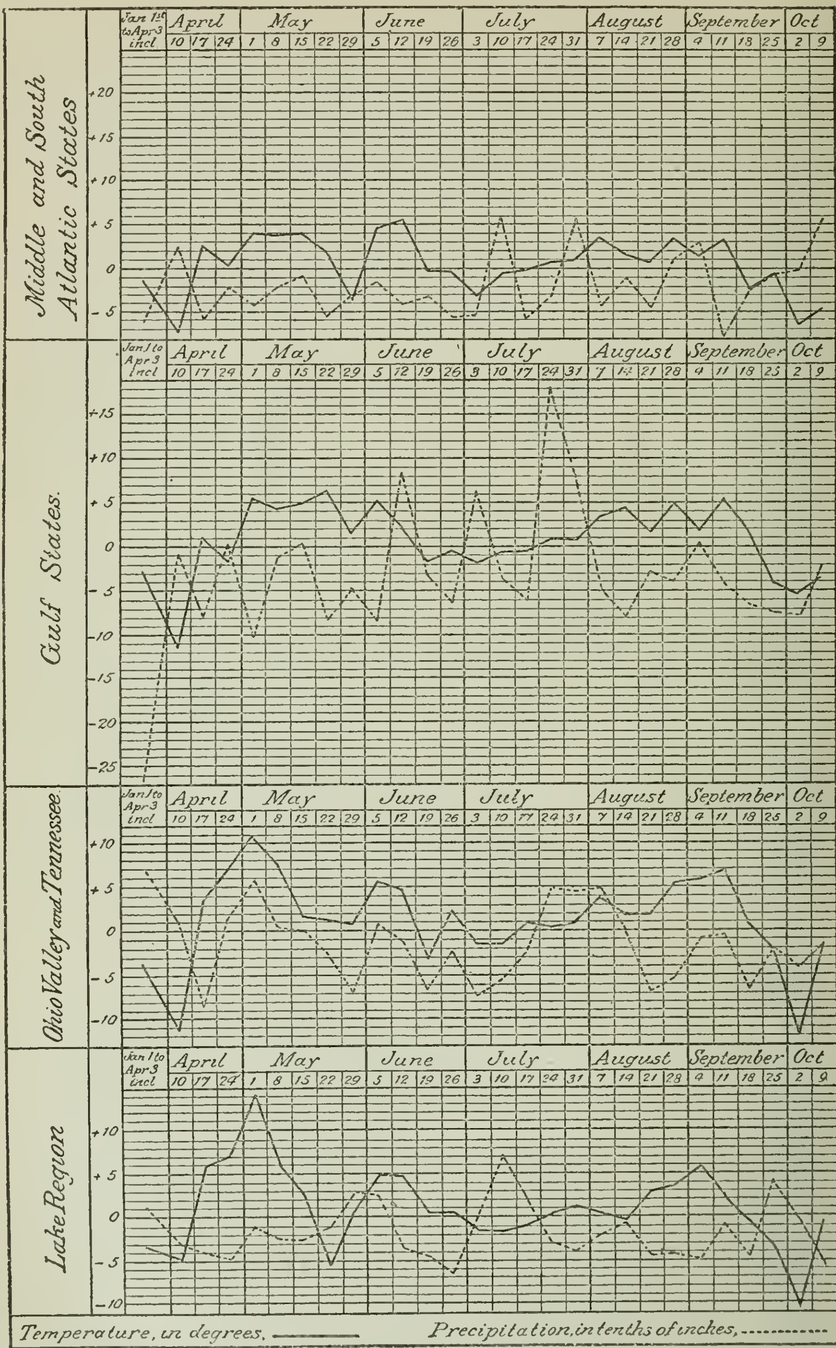


FIG. 32.—Temperature (degrees Fahr.) and precipitation (inches) departures for the season of 1899 from the normal of many years for the middle and South Atlantic States, the Gulf States, the Ohio Valley and Tennessee, and the Lake region.

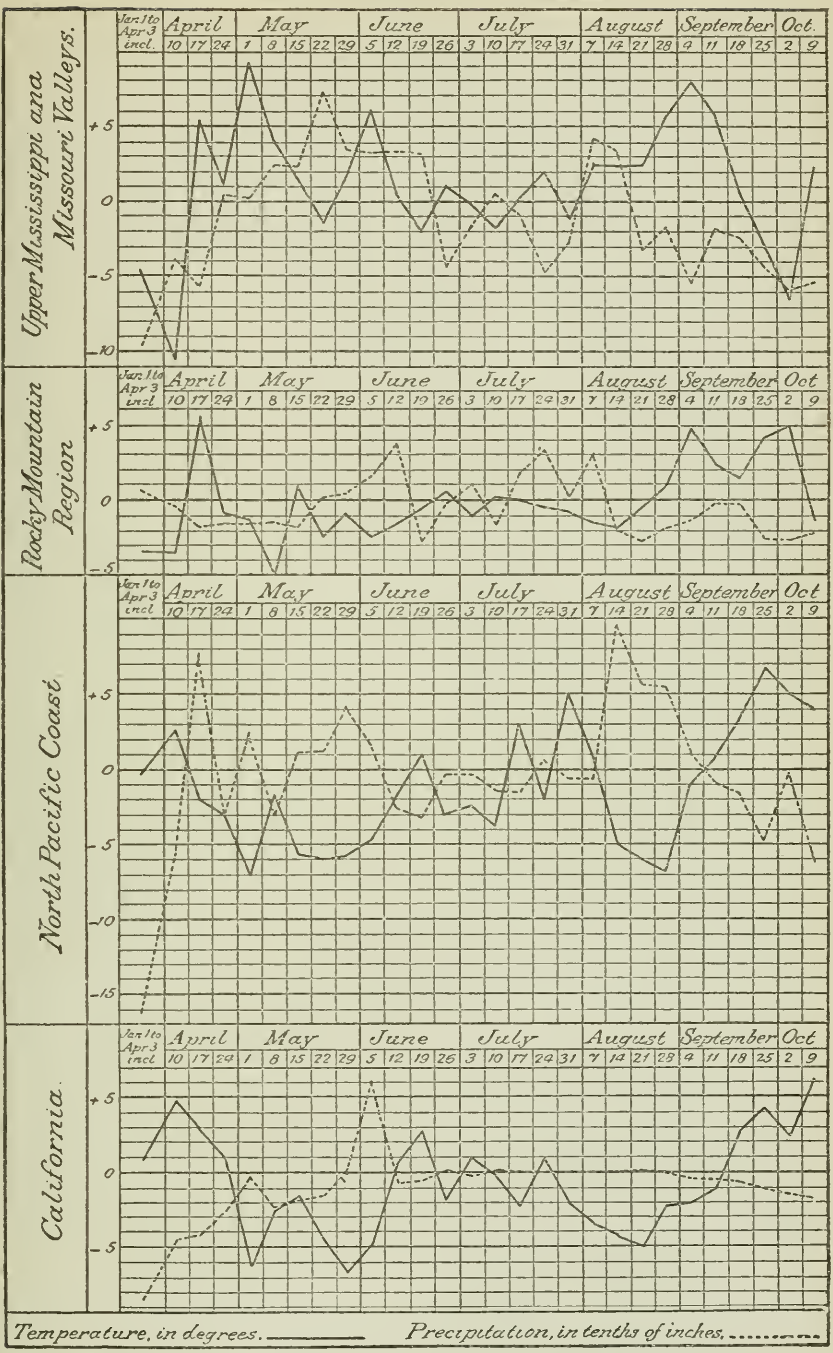


FIG. 33.—Temperature (degrees Fahr.) and precipitation (inches) departures for the season of 1899 from the normal of many years for the Upper Mississippi and Missouri valleys, the Rocky Mountain region, the North Pacific coast, and California.

farm work in the more southerly portions of these sections. Light to heavy frosts occurred as far south as northern Georgia, causing some injury to corn and garden truck. In the Gulf States, including Arkansas, corn planting was nearly completed and was in progress in the central portions of Missouri and Kansas, but east of the Mississippi practically no corn has been planted north of Tennessee and North Carolina. Over the central portions of the Gulf States the stand of corn was generally good, but in Georgia and Texas much replanting was necessary. The reports generally showed a decided improvement in winter wheat in the States east of the Rocky Mountains as compared with the unfavorable conditions at the close of the previous week. On the Pacific coast the condition of wheat continued unfavorable in Washington, but in Oregon and California the outlook was promising. Rapid progress was made with spring-wheat seeding over the southern portion of the spring-wheat region and a little was sown as far north as North Dakota. Oat seeding which was previously confined to the States south of the Ohio and Missouri rivers was now well advanced in Illinois, and was in progress in Indiana and the Middle Atlantic States, a general improvement in the condition of the crop in the Southern States being reported. Over the central and southern portions of the cotton belt the planting of cotton was vigorously pushed, and the early planted was coming up over the southern portions of the east Gulf States. In southern Texas cotton planting was nearly completed and was well advanced in the northern part of the State. Some tobacco had been planted in South Carolina.

April 24.—The weather conditions of this week were generally less favorable than in the preceding week. Portions of eastern Kansas, Missouri, Oklahoma, and western Arkansas, and local areas in Alabama suffered from excessive rains, while light rains would have proved beneficial in southern Michigan and portions of the Upper Ohio Valley and Middle Atlantic States. In the west Gulf States and generally to the eastward of the Mississippi River, however, the weather conditions were very favorable. Further improvement was reported in the condition of winter wheat, although it was apparent that much of the crop had been winterkilled, especially over the northern portions of Missouri, Illinois, and Indiana, and in northwestern Ohio. Spring-wheat seeding was nearly completed over the southern portions of the spring-wheat region, but was delayed by unfavorable soil conditions over the northern portion. The bulk of the oat crop was sown, except in the more northerly sections, where seeding continued. In the central valleys the early sown oats were coming up well and the crop was beginning to head in the Southern States, where the outlook was generally promising. Cotton planting was general over the northern portion of the cotton region, except in Oklahoma and northern Texas, where it was delayed by wet weather. West of the Mississippi, corn was being planted as far north as southern Nebraska, and east of the Mississippi, in the southern portions of Illinois, Indiana, and Ohio, and in West Virginia and Maryland. Wet weather retarded corn planting in Missouri, but rapid progress was made in Tennessee, Virginia, and North Carolina.

May 1.—In the districts east of the Rocky Mountains the temperature conditions of this week were highly favorable. There was, however, too much rain in portions of the Missouri and Red River of the North valleys; and destructive local storms occurred in portions of Kansas, Missouri, and Georgia, while rain was needed in the central Gulf States, Ohio Valley, Middle Atlantic States, and southern New England. In the Rocky Mountain districts and on the Pacific coast the week was unfavorable owing to unseasonably low temperatures and frequent frosts, which were more or less destructive. In the States of the Ohio, Central Mississippi, and Lower Missouri valleys the weather was exceptionally favorable for planting, germination, and the growth of corn, and rapid progress in planting was made. In the Southern States corn made good growth and was being cultivated. Where not winterkilled, general improvement in the condition of wheat was reported, especially in the Ohio Valley, Tennessee, and Middle Atlantic States. In California and Oregon the outlook for wheat continued favorable, but the condition of the crop in Washington was less promising than previously reported. In the southern portion of the spring-wheat region early sown wheat was coming up to good stands. Seeding was about finished over the southern portions of Minnesota and North Dakota, but was delayed in the Red River of the North Valley and Oregon. Cotton made favorable growth over the central and southern parts of the cotton belt, planting being well advanced over the northern part.

May 8.—Over the eastern portions of the country the temperature conditions of this week were favorable, but it was too dry in portions of the Middle Atlantic and Gulf States. In the Rocky Mountain and Pacific coast districts the week was much too cool, and frosts in the Rocky Mountain region were destructive to fruit. In the Middle Atlantic States, and generally in the central valleys, excellent progress was made with corn planting, which was in progress as far north as

New York, Michigan, and South Dakota. Early corn was being cultivated in North Carolina, Tennessee, and the southern portions of Missouri and Kansas. The general condition of winter wheat continued to improve, the outlook in California being very promising. This week marked the completion of oat seeding in the more northerly sections and, with the exception of the west Gulf States, where the crop was suffering for rain, the outlook was generally promising. Early planted cotton made favorable progress over the southern and central portions of the cotton belt, but the crop was suffering for rain in portions of South Carolina, Florida, and Louisiana. In northern Texas considerable replanting was made necessary by reason of heavy washing rains. Tobacco plants were scarce in some sections of Virginia and Maryland, but were abundant in other portions of the Middle Atlantic States and in the Ohio Valley.

May 15.—The most unfavorable features of this week were the unseasonably low temperatures on the North Pacific coast, the continued absence of rain over the greater part of the Gulf States, and excessive rains in the Ohio and Mississippi valleys. Except on the North Pacific coast, however, the temperature conditions were decidedly favorable and crops generally made good growth except in portions of the Gulf States where drought prevailed. While frosts were frequent in portions of the lake region, Upper Mississippi, and Upper Missouri valleys, no serious damage resulted. Heavy rains delayed corn planting in Missouri, Iowa, Illinois, and Indiana; but elsewhere over the northern portions of the country planting progressed favorably, and about half the intended acreage was planted in Illinois and Ohio. Winter wheat made rapid growth in the States of the central valleys. In Washington an improved condition was reported; but in California dry northerly winds proved injurious in some sections. Spring-wheat seeding was still unfinished in Minnesota and North Dakota, but over the southern portions of the spring-wheat region the crop made good growth and was stooling well. Oats were injured by frosts in South Dakota but generally made rapid growth, except where suffering from drought in the central Gulf States, South Carolina, and Nebraska. The oat harvest began this week in Florida. In the Carolinas and Georgia cotton made favorable progress, but in the central portion of the cotton belt it suffered from insects and drought. Replanting of cotton continued in the washed-out regions of northwest Texas, the bulk of the crop in that State being up to good stands and growing rapidly, but was badly in need of cultivation in the northern and central portions. Some tobacco was planted in Kentucky, Ohio, and Virginia, but farther north no planting had been done.

May 22.—In the Pacific coast and Rocky Mountain regions and in the northern districts east of the Missouri Valley this week was unseasonably cool and unfavorable for germination and growth, and while there was ample warmth in the Southern States the continued absence of rain over a large part of that section proved very unfavorable. Too much rain in western Kentucky and portions of Missouri and Arkansas retarded the cultivation of crops in those States. Winter wheat sustained considerable damage from insects in the central valleys and Middle Atlantic States, and the general condition of the crop in the States east of the Rocky Mountains was less encouraging than in the previous week; the crop was also unfavorably affected by cool weather on the North Pacific coast. In the central portions of the cotton belt insects caused serious damage to cotton, which, over the southern portions of the Gulf States and in Florida, was suffering seriously for rain. In Texas the weather was especially favorable for clearing the crop of grass and weeds.

May 29.—In the Middle and South Atlantic States this week was much too cool, but elsewhere east of the Rocky Mountains the temperature conditions were very favorable. In the Gulf States the protracted drought was largely relieved by ample moisture, and portions of Wisconsin, Illinois, Iowa, Missouri, and Arkansas suffered from excessive rains. The weather continued unseasonably cool on the North Pacific coast where excessive moisture continued to retard farming operations. In Washington, however, this week was the most favorable of the season to date. Corn was generally reported backward and made slow growth from the Missouri and Central Mississippi valleys eastward to the Middle Atlantic coast, but in Kansas and in the east Gulf States it made decided advancement. The general condition of winter wheat in the States of the Ohio, Central Mississippi, and Lower Missouri valleys was probably less favorable than in the previous week, the crop having suffered considerable damage from rust and insects. Some improvement, however, was reported in Nebraska, Iowa, Pennsylvania, New York, and in portions of Oklahoma and Arkansas. Harvesting began this week in some of the Southern States. The week was highly favorable for spring wheat in the Dakotas and Minnesota, and the crop did well in Nebraska and Iowa. Cotton improved over the eastern portion of the cotton belt except in the Carolinas, where it was too cool, but made slow growth in portions of Louisiana and Mississippi, where it suffered from drought. In Texas cotton grew rapidly and was well cultivated, except in some localities in the northern portion of the State. For lack of rain tobacco setting was not general, but much ground was prepared.

June 5.—From the Rocky Mountains eastward very favorable temperature conditions were experienced; but on the Pacific coast the season continued very backward and unseasonably low temperature prevailed. In the principal corn States the weather was more favorable for this staple than in the preceding week, although cultivation was extensively retarded as a result of general rains in the Missouri, Central Mississippi, and Ohio valleys, planting being delayed in portions of Illinois, Iowa, and North Dakota. Over the greater part of the Southern States corn was suffering for rain, but in Nebraska, Kansas, Oklahoma, Kentucky, and Tennessee and over the greater part of the Middle Atlantic States its condition was generally promising. The harvesting of winter wheat was quite general in the Southern States, some having been cut as far north as Tennessee and Arkansas. Reports indicated no improvement in this crop in Missouri, but as a rule the reports from the Ohio Valley and Middle Atlantic States were favorable. In the Dakotas, Minnesota, and Iowa, spring wheat made rapid growth and was in promising condition. In the Carolinas and Georgia the condition of cotton was, as a whole, satisfactory; but in the central portion of the cotton belt rain was greatly needed, especially for germination, and, while the crop was generally doing well in Texas, the southern portions of the State needed rain also. With rains in the Ohio Valley, Maryland, and Virginia, transplanting tobacco was rapidly pushed.

June 12.—The rains of this week largely relieved the drought in the Southern States, although portions of northern Louisana and eastern Texas continued to suffer. There was too much rain in Kansas, over the southern portions of Missouri, Illinois, and Indiana, and portions of the upper lake region and Minnesota. Unseasonably cool weather continued on the north Pacific coast and in the northern Rocky Mountain districts. In the central valleys corn made good growth and its condition generally improved, but cultivation was much retarded. In portions of the Southern States corn suffered for rain, especially in Georgia, Florida, and southern Texas. Winter wheat harvest was now in progress as far north as the Ohio and central Mississippi valleys and about finished in the east Gulf and South Atlantic States. On the north Pacific coast wheat made rapid growth under the most favorable conditions that had been experienced to date, and although the wheat crop in California was subjected to excessively high temperatures, it escaped injury, owing to the absence of high winds. The reports respecting spring wheat were less favorable than in the preceding week, as the result of excessive moisture, especially on the lowlands of Minnesota and North Dakota; on uplands in these States, however, it made luxuriant growth, and lodging was threatened in portions of Minnesota. Oat harvest was nearly completed this week in the Southern States, and over the northern sections the general condition of the crop was more promising, although damage from rust and too rank growth was reported from portions of the Mississippi Valley. Cotton improved in the Carolinas, Georgia, Alabama, Mississippi, and Tennessee, although the stands in Tennessee and Alabama were reported as poor; in Texas it was well cultivated and made good growth. Rapid progress continued in transplanting tobacco in the Ohio Valley and Middle Atlantic States; in Florida and portions of Tennessee and the Carolinas the crop suffered from drought. Haying was in general progress in the central valleys, Middle Atlantic States, Oregon, and California.

June 19.—On the Pacific coast this was the best week of the season to date, affording ample warmth and sunshine, conditions much needed in Oregon and Washington. While heavy rains delayed cultivation and caused damage to crops in portions of the Mississippi and Missouri valleys, and drought continued over portions of New England, the Middle Atlantic States, Tennessee, and the central and southern Rocky Mountain region, the week, as a whole, was favorable for crop growth. Corn made good progress in all districts, and a part of the crop received its final cultivation as far north as Missouri and southern Illinois. Winter wheat harvest was interrupted by rains in portions of the central Mississippi and Lower Ohio valleys. Damage from rust was reported from Michigan and Pennsylvania, and from drought in New York, while grain in shock sustained injury in portions of Texas. Heavy rains in Minnesota caused injury to spring wheat in that State and also in Iowa, but elsewhere a general improvement in the condition of the crop was reported. The reports from nearly all sections of the cotton belt indicated a general improvement in cotton, but in portions of eastern Texas, Arkansas, and Oklahoma, it needed cultivation.

June 26.—Over much the greater part of the country the weather conditions of this week were highly favorable, particularly in the Middle Atlantic States and central valleys and on the north Pacific coast. Local storms, however, caused damage in portions of the lake region and upper Ohio Valley, while drought continued in portions of New England, the South Atlantic and Gulf States, and in central Tennessee. Corn made marked progress in the principal corn States, and in those States where cultivation had been retarded the fields were cleaned. A considerable part of the crop had received its final cultivation in Kansas, Missouri, Illinois, and Indiana. Winter-wheat harvest continued under favorable weather conditions, and was in progress in the more northerly sections of the winter-wheat region. A large crop of excellent quality was being harvested in California, and, in Oregon and Washington, wheat made rapid advancement. The outlook for spring wheat continued promising, with less danger from rank growth and lodging. Except over portions of southern Texas, Louisiana, and Mississippi cotton made favorable progress, and as a whole was well cultivated.

July 3.—This was a cool week on the north Pacific coast and over most of the country east of the Rocky Mountains. As in the previous week corn made favorable progress in the principal corn States, although suffering for rain in Missouri. The harvesting of late winter wheat continued under favorable weather conditions in the more northerly sections and in California. Spring wheat continued promising and the crop was heading in the southern portions of the spring-wheat region. Cool nights retarded the growth of cotton to some extent over the eastern part of the cotton belt, while in portions of the Carolinas, Tennessee, and Arkansas it was suffering for rain, but the crop generally made good growth. The heavy rains in Texas, however, inundated a large acreage. Tobacco suffered from drought and insects in Kentucky and Tennessee, but the reports from the other tobacco States were generally favorable. The most noteworthy feature of the weather of this week was the phenomenally heavy rains which fell on June 28 and 29 over the drainage basin of the Brazos River in the central portion of Texas, and which were followed by heavy rains for four or five days in succession. On June 29 all the tributaries of the Brazos River from McClennan County south to Brazos County were higher than ever before. This water with that of succeeding rains caused a flood in the Brazos which covered all low lands from 2 to 12 feet deep. It is said that in places the river was more than 12 miles wide. The flood moved southward very slowly, and it was fourteen days from the time the crest of the flood was noted in central Texas until it passed out into the Gulf of Mexico.

July 10.—This week was marked by absence of high temperatures in the districts east of the Rocky Mountains, in which the weather conditions were generally favorable for farming operations and crop growth, especially in the States of the Upper Mississippi and Missouri valleys and on the Atlantic coast. Excessive rains, however, caused some damage to grain in shock in Kansas and Texas, while drought continued in the Gulf States, Tennessee, and portions of the Ohio Valley. Rainfalls amounting to from 0.50 to 0.75 inch occurred over a considerable portion of the drainage basin of the Brazos River, but the conditions on the whole were favorable for the subsidence of the waters in the inundated districts. Generally, corn made rapid growth in the principal corn States, but suffered from drought in portions of Ohio, Kentucky, and central Tennessee. This week marked the completion of the winter-wheat harvest, except in the extreme northerly sections, where it was well advanced. In Kansas and Texas some damage resulted from sprouting in shock. In the eastern and central portions of the cotton belt and outside the flooded region in Texas cotton made good progress, the sea island crop in South Carolina being very promising. Tobacco suffered much from drought in Tennessee and in portions of Kentucky and Ohio, but in the Carolinas, Middle Atlantic States, and New England the general outlook was much improved.

July 17.—The absence of rain over a large part of the Gulf and South Atlantic States in this week intensified the previously existing drought conditions in that section, more particularly over the interior portions of the central and east Gulf States, middle Tennessee and the western portions of the Carolinas, while excessive and continuous rains in central Wisconsin proved unfavorable. The eastern portions of Oregon and Washington experienced high temperatures with drying winds that were detrimental to the grain crops of those States. Over a large part of Texas, including the greater part of the inundated region, there was an almost total absence of rain, but the bottom lands of the Brazos basin were not yet dry enough for cultivation. The weather conditions of this week were favorable for the growth and development of crops and for general farming operations in the central valleys, New England, Middle Atlantic States, and generally throughout the central and southern plateau region and in southern California. Corn suffered from drought in the South Atlantic, central and east Gulf States, central Tennessee, southern Missouri and in portions of Kentucky and Virginia, but in the Middle Atlantic States and generally throughout the central valleys the week was very favorable for corn, which made excellent growth in these districts. The harvesting of spring wheat began in Iowa, the reports respecting this crop being generally favorable throughout the greater part of the spring wheat region. The general condition of cotton in the eastern portion of the cotton belt was less favorable than in the preceding week, due principally to the continuation of drought, but in part to the ravages of insects. The crop in Missouri, Arkansas, Mississippi, Oklahoma, and Texas, except in the flooded region, however, generally improved. The first picking of the season was reported this week from southern Texas. In Kentucky the tobacco crop was greatly improved and the outlook continued promising in the Middle Atlantic States, New England, and portions of Ohio and Indiana.

July 24.—Much-needed rains fell this week in Tennessee and in the central and east Gulf States, although portions of Mississippi continued to suffer. Rain was also needed in southern Texas, Nebraska, the Dakotas, portions of Illinois, Indiana, the Middle Atlantic States, and New England, but upon the whole the general weather conditions were favorable for crops in the States of the central valleys and Lake Region, and on the middle Atlantic coast. Crops experienced a marked improvement in the middle Rocky Mountain States. Over the greater part of the central and western portions of the cotton belt, the condition of cotton was somewhat more favorable than at the close of the previous week, the crop being well cultivated; but over the eastern portion shedding was reported, with complaints of drought in portions of the Carolinas. Rains caused marked improvement in tobacco in Kentucky and Tennessee, and the general condition of the crop in the Ohio Valley, Middle Atlantic States, and New England was very promising, except in portions of Pennsylvania and Virginia.

July 31.—The drought was relieved this week in the South Atlantic and east Gulf States, and beneficial rains fell in Ohio and Indiana; but rain was needed in portions of New York and Pennsylvania, the central portions of Illinois and Missouri, and in Louisiana, Arkansas, the Dakotas, western Nebraska, and central Colorado. Local storms with very heavy rains proved damaging in Alabama, western Florida, and southern New Jersey; but, notwithstanding these conditions, the week may be said to have been generally favorable. While corn would have been benefited by rains in central Illinois and portions of Missouri, Iowa, Nebraska, and South Dakota, the crop made satisfactory progress in the principal corn States, the outlook in Kansas being considered the best in years. At this date early corn was matured as far north as Missouri and southern Illinois. High winds, with temperatures exceeding 100° in South Dakota, caused injury to spring wheat, and, while the heat in North Dakota was not so excessive, the crop was more or less damaged in that State. Over the eastern portion of the spring-wheat region the crop was more promising. Spring wheat also sustained some injury from hot winds in Oregon and portions of Washington. While rains improved the condition of cotton in the Carolinas, the excessively heavy rains in North Carolina proved injurious. Good growth was, however, generally reported, especially in the eastern sections of the cotton belt, although complaints of shedding were numerous. Picking was well advanced in portions of southern Texas. Tobacco suffered from drought in New York and on low lands in Tennessee by heavy rains, but elsewhere the crop experienced marked improvement, especially in the States of the Ohio Valley. Considerable progress was made with plowing for fall seeding in the central valleys and Middle Atlantic States.

August 7.—As a whole, crops generally made satisfactory advancement this week in the States of the central valleys, as well as over the greater part of the Atlantic coast and east Gulf States, Lake region, central and southern Rocky Mountain regions, and on the Pacific coast. Drought prevailed, however, over the greater part of Texas and Oklahoma, and in portions of the Dakotas, Minnesota, Wisconsin, New York, New England, Pennsylvania, Virginia, and the Carolinas, while excessive rains delayed work in southern Minnesota and upper Michigan, and local hailstorms proved destructive in portions of the Middle Atlantic States. The general condition of corn was further improved, an abundant crop being promised in the great corn States of the central valleys, as well as in the Middle Atlantic States. The spring-wheat harvest was interrupted by rains in southern Minnesota, and thrashing retarded in Nebraska and Iowa. Severe hailstorms caused much injury to spring wheat in northeastern North Dakota. In Washington and Oregon good harvesting weather prevailed. While rust and shedding in cotton were quite generally reported, the condition of the crop over the central and eastern portion of the cotton belt was somewhat improved. In portions of Louisiana and Arkansas and over the greater part of Texas, rain was badly needed and the condition of cotton less promising than at the close of the previous week. Picking was now in progress in central Texas and over the southern portions of the central and eastern districts, first bales having been marketed in Alabama and South Carolina. In the principal tobacco States the weather conditions were highly favorable for tobacco, which was reported as much improved in Kentucky, Tennessee, and North Carolina. The soil was in fine condition for plowing for fall seeding in the central valleys and Middle Atlantic States.

August 14.—Very favorable weather prevailed during this week in the Ohio Valley, and generally in the Middle and South Atlantic and east Gulf States, throughout the central and southern Rocky Mountain districts and on the Pacific coast, while drought prevailed in the lower Lake region, southern New England, and portions of the central and west Gulf States. The lower Missouri, Red River of the North, and central Mississippi valleys suffered from excessive rains, and in Wisconsin, Minnesota, and North Dakota destructive hailstorms occurred. Rainfalls of from 0.50 to more than 1 inch, remarkable for the season, occurred in Washington and Oregon, and, although retarding harvesting in Oregon and causing some damage to oats in Washington, were generally beneficial. This was another very favorable week for corn. Except over southern Missouri, central Kansas, and in central and western Nebraska, where it needed rain, the crop generally made further advancement. Stacking and thrashing of spring wheat was generally delayed by rains, and violent hailstorms in the Red River Valley caused the loss of about 50 per cent of the expected yield of 50,000 acres in Minnesota, while high winds lodged and shelled considerable ripe grain in North Dakota. In nearly all sections cotton opened rapidly, and picking was in general progress. While complaints of shedding continued, they were somewhat less numerous than in the previous week over the eastern half of the cotton belt. Rust was, however, prevalent and increasing in the central and eastern districts. In the north-central and western portions of the cotton belt the condition of cotton was decidedly less promising than at the close of the previous week. The condition of tobacco continued favorable except some damage from storms in New York, from too much rain in southern Indiana, and from drought in Pennsylvania. Cutting was now in progress in the Ohio Valley and middle Atlantic States. Plowing for fall seeding was exceptionally well advanced.

August 21.—While there was an entire absence of rain over a large part of the country east of the Rocky Mountains, very heavy rains fell in the Red River of the North Valley, on the Virginia and North Carolina coasts, and over portions of the central Gulf States. In the Pacific coast States the week was too cool, and rains in Washington and Oregon interrupted harvest. In the principal corn States favorable temperature conditions and general absence of rain advanced the maturity of corn, the general condition of which was very satisfactory, although late corn needed rain in portions of the Ohio and upper Mississippi valleys, in Oklahoma, and parts of Nebraska and Kansas, cutting being general in the last-named State. Spring-wheat harvesting was delayed in the Dakotas and Minnesota by heavy rains, which caused injury to stacked grain in Minnesota. Over the central and eastern portions of the cotton belt the condition of cotton continued practically as at the close of the preceding week, rust and shedding being prevalent. Cotton opened rapidly and picking was in progress in the northern portions of the cotton belt. Drought proved very damaging to cotton in Oklahoma and Texas, but the weather was very favorable for picking. Tobacco suffered from drought in Ohio, but in other tobacco States the general outlook continued favorable, although some damage was caused by high winds in North Carolina, and moist weather proved unfavorable for curing in Maryland.

August 28.—The drought was relieved locally in the South Atlantic States, but continued with increased severity in Texas, Oklahoma, southern Missouri, and Michigan. Very favorable weather conditions prevailed in Iowa, northern Missouri, Nebraska, and Kansas, but, as in the previous weeks, reports of damaging effects of excessive moisture were received from the Dakotas and Minnesota. Abnormally cool weather continued on the Pacific coast, with rains unusual for the season in Washington and Oregon. In California the persistent prevalence of low temperatures proved injurious to raisin grapes. The general condition of corn in the States of the central Mississippi and Ohio valleys was less satisfactory than in the previous week, owing to continued absence of moisture, which conduced to too rapid maturity. In Iowa, northern Missouri, Kansas, Nebraska, the Dakotas, Minnesota, and the Middle Atlantic States the weather was more favorable to corn, and the crop generally made good progress, although late corn was somewhat less promising in portions of Nebraska and Kansas. The reports of injury to grain in shock and stack continued from the Dakotas and Minnesota principally, however, as a result of the rains of the previous weeks. Grain in shock was also injured by rains in Washington and Oregon, but in the last-named

State the rains were of material benefit to late spring grain and other crops. While complaints of rust and shedding in cotton were somewhat less numerous in the eastern portion of the cotton belt, they continued undiminished in the western districts, where there was quite a general deterioration in the condition of the crop. Favorable progress was made in cutting and housing tobacco, which work was quite well advanced.

September 4.—At the close of this week a very large part of the country was suffering from drought of greater or less severity, high temperatures having prevailed with no rain in nearly all districts suffering from the lack of rain at the close of the preceding week. Very favorable weather conditions, however, prevailed on the Atlantic coast, except in portions of New England and North Carolina, which were suffering from drought. The weather continued cool over the greater part of the Pacific coast, but generally was more favorable than in the preceding weeks. Under the prevailing high temperatures corn made rapid progress toward maturity, the late corn having ripened too rapidly. Reports of injury from excessive moisture to grain in shock and stack continued from portions of Minnesota, South Dakota, and Washington. Cotton picking was retarded by rains in portions of the east Gulf States and on the Texas coast, but in other portions of the cotton belt picking made rapid progress. Reports of rust and shedding, as a rule, were less numerous, and were confined principally to the central portion of the cotton belt. In portions of South Carolina, Georgia, and Florida, cotton sustained injury from rain and sprouting and rotting of bolls in places; in Georgia, however, the crop improved. Tobacco matured rapidly, and favorable progress was made in cutting and housing the crop. The condition of the soil was very favorable for plowing and seeding in the Middle Atlantic States, but in the central valleys and southwest this work was largely suspended owing to dryness.

September 11.—While the first half of this week was excessively hot and dry over the greater part of the country east of the Rocky Mountains, there were beneficial rains during the latter part which partially relieved the droughty conditions in portions of Texas and Oklahoma, the central Mississippi and Ohio valleys, and generally throughout the Middle and South Atlantic States. Drought continued, however, in portions of New York, Pennsylvania, Ohio, Wisconsin, Kentucky, and over the greater part of Tennessee, Arkansas, Mississippi, Oklahoma, and Texas. The cutting of early corn, the greater part of which was now safe from frost, was general in all sections, the maturing of the crop having been rapidly advanced by hot and dry weather of the previous weeks. Late corn was materially injured by heat and drought in portions of Ohio, Indiana, Illinois, Nebraska, and southern Missouri, but in Iowa it was not as badly injured as the previous reports indicated. In the Dakotas and Minnesota the conditions were favorable for spring wheat harvesting and thrashing, although thrashing was prevented to some extent by local showers in Minnesota. In Washington and Oregon harvesting was vigorously pushed, the absence of rain being especially favorable. Reports of premature opening of cotton were general in the eastern and central portions of the cotton belt and picking progressed rapidly in all sections. The crop sustained damage from local storms in South Carolina and Georgia and drought in Arkansas. The prospects for the top crop were generally very poor. The bulk of the tobacco crop was cut and housed in the more northerly tobacco States.

September 18.—Rain was very generally needed, more particularly for plowing and fall seeding, from the east Gulf coast northward over Tennessee, the upper Ohio Valley, interior portions of the Middle and South Atlantic States, lower Lake region, and northern New England, over much the greater portion of which area practically no rain fell during the week. Drought continued over a large part of Texas, and rain was needed in Nebraska and portions of Iowa, Wisconsin, and Michigan. Some late corn in northern Michigan and portions of Wisconsin, New York, and northern New England was injured by frost, but on the whole the weather conditions were favorable for the unmatured portion of the crop. Late corn in the central valleys suffered material injury in consequence of drought. In the Dakotas and Minnesota, where the thrashing of spring wheat had been much delayed, the weather conditions were favorable for this work. The north Pacific coast region also experienced favorable weather for the completion of harvesting and thrashing, the reports from Oregon indicating that the injury resulting from the rains of August was less serious than was anticipated. The weather was very favorable for cotton picking over the greater part of the cotton belt. Premature opening continued in all districts and the reports generally indicated that the crop would be gathered at a much earlier date than usual, and that the top crop would be very short, in some sections almost a failure. The weather was also favorable for finishing the tobacco harvest and for curing.

September 25.—As no rain fell over a large part of the Southern States the drought of the previous week continued, and rain was needed over portions of Illinois, Iowa, Nebraska, and in the southern Rocky Mountain regions. Throughout the central and northern portions of the country and on the Pacific coast the weather was generally favorable for maturing crops and for farm work. The corn crop experienced generally favorable weather conditions. In the States of the Ohio Valley and lake region a large part of the crop had been cut and some husking had been done. Reports continued to show that late corn had failed to develop well in the central valleys and Southern States. The absence of rain on the Pacific coast was favorable for the completion of the grain harvest and for thrashing in Washington and Oregon, where the damage from the August rains was much less than had been expected. Cotton picking made rapid progress under favorable weather conditions. Nearly the whole crop was open and the bulk was gathered over a large part of the cotton region. Except over limited areas in Virginia and North Carolina, the tobacco crop was practically cut and housed, the weather of this week proving generally favorable for curing. Excellent progress was made with plowing and fall seeding in the Ohio Valley, Middle Atlantic States, and New England, but generally throughout the Southern States and in the upper Mississippi Valley the soil was too dry. In the Ohio Valley and Middle Atlantic States early sown grain was germinating finely.

CLOSE OF THE SEASON IN OCTOBER.

The monthly climate and crop bulletin for October, 1899, showed that in the districts east of the Rocky Mountains the month was very mild and the first half generally dry. These conditions proved very favorable for maturing and gathering late crops, but were not favorable for plowing, fall seeding, and germination of sown grain over a large part of the winter-wheat region. During the latter part of October the drought conditions were largely relieved, although Iowa and portions of eastern Nebraska, northern Missouri, and the central Gulf States were suffering for rain at the close of the month. Under exceptionally favorable weather conditions cutting, husking, and cribbing of corn made rapid progress. Only a small part of the cotton crop remained ungathered at the close of the month. Although the top crop was very light, the absence of frost, especially over the eastern part of the cotton belt, permitted much to mature.

TEMPERATURE FOR THE SEASON IN THE SEVERAL REGIONS.

Plate LXI shows that for the period from March 1 to October 9 (223 days) the Southern States, Ohio Valley, and lower Lake region received more than the usual amount of heat, the average daily excess ranging from 1° to 2° over an area extending from central Texas northeastward to New York. Along the Middle Atlantic and Gulf coasts the average seasonal temperature was nearly normal. From the upper Mississippi Valley westward to the Pacific coast, including the middle plateau region and California, the season averaged cooler than usual, the deficiency in temperature being very marked from the upper Missouri Valley westward to Idaho, Oregon, and northern Nevada, where it ranged from 2° to 4° per day.

RAINFALL FOR THE SEASON IN THE SEVERAL REGIONS.

Plate LXII shows the total rainfall for the period from March 1 to October 9; and Plate LXIII the excess or deficiency as compared with the normal. Except over eastern Texas and southern Florida, the seasonal rainfall in the Southern States was was much lighter than usual, the deficiency ranging from 4 to 16 inches. There was also a marked deficiency over the northern portion of the Ohio Valley, the greater part of the Lake region and New England, and throughout the central and southern Rocky Mountain districts. The total rainfall over the greater part of the Middle and South Atlantic and east Gulf States generally ranged from 24 to 40 inches, like amounts occurring over portions of the central Gulf coast and eastern Texas, while the region from Arkansas and northern Texas northward to Lake Superior received from 24 to 30 inches. Over much of the lower Lake region and northern New England the total rainfall amounted to less than 18 inches. The normal seasonal rainfall over a large portion of the central and southern plateau regions is less than an inch, but during the present season even this small amount did not fall, the total for Yuma, Ariz., for 223 days, being only 0.01 inch.

Average daily temperature departures (in degrees Fahrenheit) for the season of 1899 from the normal, based upon observations for many years, by sections.

Sections.	From Jan. 1 to Apr. 3, inclusive.	For weeks ending— April— 10.	17.	24.	May— 1.	8.	15.	22.	29.	June— 5.	12.	19.	26.
Middle and South Atlantic States	− 1.3	− 7.2	+2.6	+0.2	+ 4.0	+3.8	+4.0	+1.8	− 3.7	+4.6	+5.7	−0.2	−0.3
Gulf States	− 2.7	−11.4	+1.1	1.6	+ 5.5	+4.2	+4.9	+6.5	+1.5	+5.2	+2.2	−1.7	.4
Ohio Valley and Tennessee	3.7	−11.4	+3.4	+7.0	+11.0	+7.5	+1.6	+1.1	+ .8	+5.6	+4.6	−3.1	+2.1
Lake region	−3.3	− 4.8	+5.8	+7.1	+14.3	+5.9	+2.5	5.5	+ .4	+4.9	+4.8	+ .3	+ .5
Upper Mississippi and Missouri valleys	−4.6	−10.5	+5.4	+1.2	+ 9.3	+4.0	+1.5	−1.4	+1.8	+6.1	+ .4	2.0	+1.1
Rocky Mountain region	3.3	− 3.4	+5.6	− .8	− 1.2	−5.0	+ .9	−2.4	.8	−2.3	−1.5	− .5	+ .5
North Pacific coast	− .3	+ 2.7	−2.0	−3.0	− 7.0	−1.7	5.7	−6.0	5.7	−4.7	−1.7	+1.0	−3.0
California	+ .8	+ 4.8	+2.8	+1.0	− 6.2	−2.6	+1.6	−4.6	−6.6	−4.8	+ .6	+2.8	−1.8

Sections.	For weeks ending— July— 3.	10.	17.	24.	31.	August— 7.	14.	21.	28.	September— 4.	11.	18.	25.	October— 2.	9.
Middle and South Atlantic States	−3.0	−0.6	0.0	+0.8	+1.0	+3.5	+1.6	+0.7	+3.3	+1.4	+3.2	−2.1	−0.4	− 6.5	−4.6
Gulf States	−1.9	− .7	− .5	+ .9	+ .8	+3.5	+4.5	+1.7	+5.0	+1.9	+5.3	+1.8	4.1	− 6.4	−3.3
Ohio Valley and Tennessee	−1.5	−1.5	+ .9	+ .4	+ .9	+3.9	+1.8	+1.9	+5.3	+5.8	+6.8	+ .5	−2.3	−12.0	−1.6
Lake region	−1.5	−1.6	− .9	+ .3	+1.1	+ .3	− .4	+2.9	+3.8	+5.8	+2.3	− .5	−3.4	−10.3	− .5
Upper Mississippi and Missouri valleys	.2	−1.8	+ .2	+2.0	−1.1	+2.5	+2.4	+2.5	+5.8	+7.9	+5.8	+ .5	−3.0	− 6.4	+2.3
Rocky Mountain region	−1.0	+ .2	.0	− .4	− .7	−1.4	− .7	− .5	+ .9	+4.9	+2.4	+1.4	+4.1	+ 5.0	−1.3
North Pacific coast	− 2.3	−3.7	+3.0	2.0	+5.0	+ .7	−5.0	−6.0	−6.7	−1.0	+ .7	+3.3	+6.7	+ 5.0	+4.0
California	+1.0	− .2	−2.2	+1.0	−2.0	−3.4	−4.2	−5.0	−2.2	−2.0	− 1.0	+2.8	+4.2	+ 2.4	+6.2

Average daily temperature departures (in degrees Fahr.) for season of 1899 from normal, based upon observations for many years, by stations.

Stations.	From Jan. 1 to Apr. 3, inclusive.	April 10.	April 17.	April 24.	May 1.	May 8.	May 15.	May 22.	May 29.	June 5.	June 12.	June 19.	June 26.
New England:													
Eastport, Me	0.4	−1	−3	−2	+4	+4	−4	−3	−1	+2	+2	0	+1
Portland, Me	1.5	−1	−1	−1	+7	−4	+2	−6	−1	+7	+3	2	0
Boston, Mass	+ .2	0	+2	+2	+10	+5	+4	−6	1	+7	+7	+2	+2
Middle Atlantic States:													
Albany, N. Y	−1.3	−2	0	+4	+12	+5	−1	−6	+1	+5	+6	+1	0
New York City	.9	−4	+4	+2	+7	+6	+3	−4	0	+6	+8	+2	+1
Philadelphia, Pa	−1.3	−3	+6	−4	+9	+6	−3	−6	−1	+6	+8	+1	+1
Washington, D. C	2.5	−8	+5	+3	+8	−4	+2	4	4	+5	+6	−2	0
Lynchburg, Va	2.7	−11	+3	+2	+5	+3	+3	+3	5	+5	+5	−3	+1
Norfolk, Va	−1.1	−8	+4	+1	+3	+1	+2	0	−6	+5	+7	0	−2
South Atlantic States:													
Charlotte, N. C	−2.6	−11	+2	+1	+1	+3	−4	+7	−5	+6	+7	−2	+2
Wilmington, N. C	1.3	−10	+2	4	+1	+1	+4	+4	−7	+2	+5	0	−2
Charleston, S. C	0	−8	+3	−3	+1	+3	+8	+7	−6	+4	+4	0	−2
Augusta, Ga	−1.4	−11	+1	−1	+1	+5	+7	+7	−5	+5	+6	−1	0
Savannah, Ga	.5	−9	+2	−4	0	+4	+8	+7	−1	+4	+4	0	−1
Jacksonville, Fla	− .1	−6	−1	−3	−1	+4	+6	+6	−2	+2	+2	0	−2
Gulf States:													
Atlanta, Ga	−2.3	−11	0	0	+4	+7	+7	+9	0	+9	+6	1	+4
Mobile, Ala	−2.6	−10	−2	−1	+3	+4	+6	+4	−1	0	+1	−1	−1
Montgomery, Ala	2.4	11	0	0	+6	+8	+7	+8	−2	+6	+5	0	+2
Vicksburg, Miss	−3.4	−13	+1	1	+6	+5	+4	+6	−1	+5	0	−2	−1
New Orleans, La	−2.1	−10	−1	−2	+4	+5	+6	+6	−1	+2	−1	0	−2
Shreveport, La	−3.1	−12	+3	−3	+6	+6	+4	+5	−2	+6	+3	−3	−1
Fort Smith, Ark	−2.1	−14	+4	−1	+9	+3	+6	+10	+3	+8	+3	−2	+1
Little Rock, Ark	4.8	−14	+2	1	+8	+2	+4	+7	+1	+7	+2	−3	0
Palestine, Tex	2.2	−13	+3	3	+7	+4	+4	+8	+5	+7	+4	−2	−1
Galveston, Tex	−2.5	−8	0	−3	0	+1	+3	+3	−2	+2	+1	−1	−2
San Antonio, Tex	−2.0	−9	+2	−3	+7	+1	+3	+5	+4	+5	0	−4	−3
Ohio Valley and Tennessee:													
Memphis, Tenn	4.1	−14	+3	+4	+11	+5	+3	+4	0	+7	+2	−2	+1
Nashville, Tenn	4.5	−14	+2	+4	+8	+9	+3	+3	0	+7	+4	−2	+2
Chattanooga, Tenn	−3.4	−12	0	0	+5	+8	−5	+7	+1	+7	+5	−2	+2
Louisville, Ky	−3.9	−13	+5	+8	+11	+8	+1	+1	0	+6	+5	−4	+3
Indianapolis, Ind	−4.5	−11	+5	+9	+13	+6	−2	−2	0	+4	+4	−4	+2
Cincinnati, Ohio	−4.6	−11	+4	+9	+12	+8	0	0	0	+4	+5	4	+2
Columbus, Ohio	−2.8	−8	+5	+12	+13	+8	0	0	+4	+6	+7	4	+3
Pittsburg, Pa	−2.1	−8	+3	+12	+15	+8	+3	−4	+1	+4	+5	−3	+2

Average daily temperature departures (in degrees Fahrenheit) for the season of 1899 from the normal, etc.—Continued.

Stations.	From Jan. 1 to Apr. 3, inclusive.	For weeks ending— April— 10.	17.	24.	May— 1.	8.	15.	22.	29.	June— 5.	12.	19.	26.
Lake region:													
Oswego, N. Y	−1.7	− 4	− 1	+ 7	+13	+ 5	− 1	− 9	+ 1	+ 4	+ 3	0	− 1
Buffalo, N. Y	− .4	− 4	+ 3	+13	+17	+ 8	+ 3	− 8	+ 3	+ 4	+ 4	0	+ 1
Cleveland, Ohio	−2.5	− 9	+ 6	+10	+18	+ 6	+ 3	− 4	+ 1	+ 5	+ 5	0	0
Detroit, Mich	−3.6	− 7	+ 6	+ 9	+18	+ 8	+ 3	− 7	+ 2	+ 6	+ 5	− 1	0
Grand Haven, Mich	−3.9	− 5	+ 5	+ 8	+15	+ 9	+ 3	− 5	+ 1	+ 5	+ 3	− 2	0
Milwaukee, Wis	−3.6	− 4	+10	+ 6	+13	+ 7	+ 4	− 4	0	+ 5	+ 6	+ 3	+ 2
Chicago, Ill	−4.8	− 7	+10	+ 5	+17	+ 5	+ 3	− 3	+ 1	+ 8	+ 7	+ 2	+ 1
Duluth, Minn	−6.0	+ 2	+ 7	− 1	+ 3	− 1	+ 2	− 4	− 6	+ 2	+ 5	0	+ 1
Upper Mississippi Valley:													
St. Paul, Minn	−5.3	− 4	+ 6	+ 2	+13	+ 6	+ 2	− 7	+ 1	+ 5	0	− 2	− 1
La Crosse, Wis	−6.2	− 6	+ 5	+ 3	+11	+ 5	+ 1	− 8	+ 1	+ 4	0	− 3	0
Davenport, Iowa	−3.9	− 7	+ 6	+ 4	+14	+ 7	+ 1	− 3	0	+ 7	+ 2	0	0
Des Moines, Iowa	−3.0	− 9	+ 4	− 1	+ 8	+ 3	− 2	− 4	+ 2	+ 8	+ 2	− 1	+ 2
Springfield, Ill	−5.2	−11	+ 4	+ 6	+13	+ 6	− 1	0	+ 2	+ 7	+ 1	− 3	+ 3
Cairo, Ill	−4.9	−13	+ 3	+ 3	+10	+ 6	+ 2	+ 3	0	+ 7	+ 3	− 4	+ 2
St. Louis, Mo	−4.3	−13	+ 6	+ 5	+14	+ 6	+ 1	+ 1	+ 1	+ 8	+ 2	− 2	+ 4
Missouri Valley:													
Springfield, Mo	−5.2	−17	+ 4	− 1	+ 9	+ 2	+ 3	+ 9	+ 3	+ 7	+ 1	− 4	+ 1
Kansas City, Mo	−4.0	−14	+ 8	0	+ 9	+ 5	+ 4	+ 1	+ 3	+ 5	0	− 1	+ 2
Concordia, Kans	−4.1	−14	+ 6	− 2	+ 8	+ 2	+ 5	+ 3	+ 4	+ 6	− 2	0	+ 2
Omaha, Nebr	−4.5	−12	+ 5	− 2	+ 8	+ 2	− 1	− 4	0	+ 5	0	− 1	0
Valentine, Nebr	−5.5	− 6	+ 8	0	+ 5	− 2	+ 2	− 4	+ 2	+ 5	− 2	− 3	0
Huron, S. Dak	−3.2	−10	+ 5	− 2	+ 9	+ 1	+ 3	− 5	+ 4	+ 5	− 2	− 2	− 1
Extreme Northwest:													
Moorhead, Minn	−1.6	− 2	+ 5	− 1	+ 8	0	+ 3	− 4	+ 2	+ 4	− 3	− 4	− 1
Bismarck, N. Dak	−6.7	− 6	+ 4	− 4	+ 5	− 3	− 2	− 7	+ 1	+ 4	− 3	− 2	− 2
Williston, N. Dak	−8.4	− 7	+ 3	− 5	+ 1	− 7	− 5	− 6	− 2	+ 1	− 6	− 6	0
Rocky Mountain Slope:													
Havre, Mont	−9.6	−10	+ 2	− 4	− 2	−15	− 4	− 7	− 3	− 2	− 4	− 2	0
Helena, Mont	−5.5	0	+ 1	− 5	− 4	− 5	− 2	− 9	− 2	− 5	− 4	+ 1	0
Spokane, Wash	−0.9	+ 1	0	− 4	− 6	− 2	− 6	− 6	− 5	− 6	− 4	0	+ 1
Salt Lake City, Utah	+0.5	+ 3	+ 6	+ 3	− 8	− 8	0	− 7	− 3	− 7	− 4	− 1	− 1
Cheyenne, Wyo	−6.9	− 2	+ 7	+ 2	0	− 5	+ 2	− 2	− 1	− 2	− 2	− 3	0
North Platte, Nebr	−4.7	− 6	+ 9	− 3	+ 3	− 1	+ 1	− 2	+ 2	+ 4	− 2	− 1	0
Denver, Col	−5.9	− 2	+10	+ 3	+ 1	− 5	+ 4	0	0	0	− 1	0	+ 1
Dodge, Kans	−3.0	−10	+ 9	− 3	+ 7	+ 1	+ 6	+ 3	+ 5	+ 5	− 2	0	+ 2
Abilene, Tex	−1.9	−13	+ 4	− 4	+ 5	0	+ 1	+ 5	+ 2	+ 4	0	− 4	− 2
Santa Fe, N. Mex	−1.2	− 1	+ 9	+ 2	0	− 5	+ 5	0	0	− 5	+ 2	0	− 1
El Paso, Tex	−0.3	− 5	+ 2	0	− 2	− 6	+ 1	+ 1	− 1	− 6	0	− 1	− 2
Phenix, Ariz	−0.2	+ 4	+ 8	+ 3	− 8	− 9	+ 3	− 5	− 3	− 9	− 3	+ 5	+ 4

Pacific Coast:													
Seattle, Wash.	−0.2	+2	−2	−2	−4	−1	−6	−4	−4	−4	−2	0	−2
Portland, Oreg.	−1.0	+2	−2	−4	−8	−3	−7	−7	−7	−6	−3	+1	−3
Roseburg, Oreg.	+0.2	+4	−2	−3	−9	−1	−4	−7	−6	−4	0	+2	−4
Red Bluff, Cal.	+1.3	+8	+7	0	−11	−1	+6	−5	−12	−3	+7	+7	−2
Sacramento, Cal.	+1.1	+7	+5	0	−7	−3	+3	−5	−10	−7	+5	+8	−2
San Francisco, Cal.	+0.5	+4	+1	−1	−4	−5	0	−5	−5	−5	−2	0	−1
Los Angeles, Cal.	+0.8	+5	+1	+3	−5	−2	0	−4	−3	−5	−3	+1	−1
San Diego, Cal.	+0.3	0	0	+3	−4	−2	−1	−4	−3	−4	−4	−2	−3

Stations.	For weeks ending— July— 3.	10.	17.	24.	31.	August— 7.	14.	21.	28.	September— 4.	11.	18.	25.	October— 2.	9.
New England:															
Eastport, Me.	−1	2	0	−3	−1	0	−3	+4	0	0	2	−3	0	0	−5
Portland, Me.	1	+1	0	−3	−1	+1	−7	+2	−2	+1	−2	−5	−1	4	−6
Boston, Mass.	1	+6	+2	2	0	+2	5	+3	3	+1	2	4	+3	2	−5
Middle Atlantic States:															
Albany, N. Y.	3	+4	+1	1	+1	−1	−3	+3	+6	+4	−3	−5	+2	−3	−5
New York City	1	+2	0	0	0	+2	1	+1	+4	+2	+1	−3	+1	4	−4
Philadelphia, Pa.	1	+1	+2	+2	0	+3	−1	−1	+3	+3	+2	−3	+2	−6	−5
Washington, D. C.	−3	−1	1	+3	1	+2	0	1	+3	+2	+4	6	0	−9	−5
Lynchburg, Va.	6	3	0	+1	+2	+4	+2	−1	+3	+2	+4	−4	3	11	−6
Norfolk, Va.	−4	+1	0	+2	+1	+3	+2	0	+3	+2	+4	−2	+1	−5	−2
South Atlantic States:															
Charlotte, N. C.	−1	−1	+2	+3	0	+4	+4	+2	+5	+2	+6	−3	−3	−9	−8
Wilmington, N. C.	−4	−3	1	−2	+2	+4	+3	1	+2	−1	+5	−2	1	7	4
Charleston, S. C.	4	2	−2	0	+2	+6	+4	+1	+3	0	+5	+1	0	5	−4
Augusta, Ga.	3	−1	+1	+1	+2	+4	+3	+2	+3	+1	+5	0	−3	8	6
Savannah, Ga.	3	2	−1	0	+2	+6	+3	+2	+3	0	+4	+1	0	5	4
Jacksonville, Fla.	3	2	−1	0	+1	+3	+3	+1	+2	0	+2	+1	−1	−4	−2
Gulf States:															
Atlanta, Ga.	0	1	+4	0	+2	+4	+5	+3	+5	+3	+9	0	−4	−9	−6
Mobile, Ala.	−2	−1	−1	+1	0	+4	+3	0	+3	+1	+3	+3	6	−8	−5
Montgomery, Ala.	2	1	0	0	+2	+2	+5	+1	+4	0	+6	+2	5	9	−7
Vicksburg, Miss.	0	1	0	+1	0	+2	+5	0	+4	+1	+4	+2	−6	8	−3
New Orleans, La.	−1	0	0	+3	0	+4	+4	0	+3	+1	+3	+2	4	−6	−4
Shreveport, La.	3	−1	1	+2	+3	+6	+7	+3	+7	+2	+7	+3	−4	6	−2
Fort Smith, Ark.	0	0	−1	−1	+2	+7	+7	+4	+10	+7	+8	0	−3	−6	−1
Little Rock, Ark.	−1	2	−1	−1	+2	+5	+7	+2	+6	+4	+7	0	−5	9	−2
Palestine, Tex.	−4	0	−2	+1	0	+2	+3	+1	+7	+2	+5	+2	3	−5	2
Galveston, Tex.	−4	−1	−1	+2	2	+1	0	0	+2	−3	+2	+4	−2	−2	−2
San Antonio, Tex.	−4	0	−2	+2	0	+1	+.3	+5	+4	+3	+4	+2	3	−2	−2
Ohio Valley and Tennessee:															
Memphis, Tenn.	1	−3	+1	−2	+1	+4	+6	+2	+5	+5	+8	+2	−3	−9	1
Nashville, Tenn.	−2	−2	+2	−1	+1	+3	+3	+2	+3	+4	+8	+1	−4	−12	−3
Chattanooga, Tenn.	0	0	+2	−1	+2	+5	+5	+4	+8	+4	+9	+1	−5	−12	−4

Average daily temperature departures (in degrees Fahrenheit) for the season of 1899 from the normal, etc.—Continued.

Stations.	For weeks ending—														
	July—					August—				September—				October—	
	3.	10.	17.	24.	31.	7.	14.	21.	28.	4.	11.	18.	25.	2.	9.
Ohio Valley and Tennessee—Continued.															
Louisville, Ky	−2	−1	+2	−1	+1	+5	−1	+1	+5	+7	+8	+1	−2	−13	−1
Indianapolis, Ind	−1	−3	0	+2	−1	+3	−1	+1	+7	+7	+7	+1	−2	−13	0
Cincinnati, Ohio	−3	−3	−1	+1	+1	+4	0	+1	+5	+6	+6	+1	−1	−12	−1
Columbus, Ohio	−1	0	+1	+3	+1	+3	+1	+3	+6	+8	+6	0	−2	−13	−2
Pittsburg, Pa	−3	0	0	+2	+1	+4	+1	+1	+3	+5	+2	−3	+1	−12	−1
Lake region:															
Oswego, N. Y	−3	+2	−1	−2	+1	0	−2	+1	+4	+5	−2	−2	0	−8	−5
Buffalo, N. Y	−2	+1	−1	−1	+2	+1	−1	+5	+4	+7	0	−1	−1	−9	−2
Cleveland, Ohio	−3	0	0	+2	+1	+1	+1	+1	+2	+6	+1	−1	−2	−12	−2
Detroit, Mich	−1	−1	−2	0	+1	0	+1	+4	+3	+5	+1	0	−6	−14	−2
Grand Haven, Mich	0	−4	−2	+4	+1	+1	0	+4	+4	+7	+2	−2	−7	−12	−2
Milwaukee, Wis	0	−4	−1	+1	+1	+1	+1	+4	+5	+8	+6	+2	−4	−10	+3
Chicago, Ill	−1	−3	0	+2	0	0	+1	+3	+4	+6	+6	+1	−5	−12	+2
Duluth, Minn	−2	−4	0	−4	+2	−2	−4	+1	+4	+2	+4	−1	−2	−5	+4
Upper Mississippi Valley:															
St. Paul, Minn	−2	−1	0	+7	0	0	+1	+3	+6	+6	+5	−1	−3	−7	+5
La Crosse, Wis	−2	−2	−2	+6	−2	0	+1	+2	+4	+7	+3	0	−5	−7	+2
Davenport, Iowa	−1	−2	0	+4	−1	+1	0	+2	+5	+9	+7	+1	−3	−11	+3
Des Moines, Iowa	−1	−4	+1	+2	−3	+1	+2	+2	+4	+10	+7	0	−3	−8	+2
Springfield, Ill	0	−2	+1	0	0	+4	+1	+1	+5	+8	+7	0	−5	−12	0
Cairo, Ill	−2	−3	+1	−2	0	+4	+5	+2	+5	+6	+8	+2	−4	−11	0
St. Louis, Mo	0	−3	+1	0	+1	+5	+1	+2	+7	+8	+8	+2	−3	−9	+2
Missouri Valley:															
Springfield, Mo	−1	0	+1	−1	+2	+6	+7	+3	+11	+8	+9	+1	−3	−4	+4
Kansas City, Mo	+1	−4	−1	−1	−1	+5	+3	+2	+4	+8	+5	0	−2	−4	+1
Concordia, Kans	+2	0	0	−2	−5	+4	+5	+2	+9	+10	+5	0	−3	+1	+3
Omaha, Nebr	−1	−4	−1	+2	−3	0	+2	+2	+3	+9	+6	0	−1	−5	+3
Valentine, Nebr	+4	+3	−1	+4	−1	0	+1	+3	+6	+7	+3	+2	−1	−2	+1
Huron, S. Dak	0	−1	+2	+7	−1	+3	+2	+5	+6	+7	+2	−1	−3	−4	+4
Extreme Northwest:															
Moorhead, Minn	+1	0	+1	+6	−2	0	−2	+7	+5	+4	+4	+1	−2	−5	+4
Bismarck, N. Dak	+2	−1	0	+6	−5	−1	−3	+3	+1	0	+4	+3	−2	−1	+4
Williston, N. Dak	−3	−1	+1	+2	−4	−4	−3	−1	−1	0	+1	+2	+2	+2	+4
Rocky Mountain Slope:															
Havre, Mont	−4	+2	+6	+2	−5	−3	−1	−3	−7	−1	+2	+2	+7	+7	−2
Helena, Mont	−3	+1	+4	+2	−4	−2	−8	−6	−9	0	+1	+1	+10	+5	+2
Spokane, Wash	−4	0	+5	−2	+1	−1	−7	−9	−11	−4	−1	+7	+9	+4	+1
Salt Lake City, Utah	+1	+3	0	−1	+2	−8	−3	−7	−5	+6	−1	0	+5	+6	−3
Cheyenne, Wyo	+2	−2	−3	+1	−1	−3	−1	0	+3	+6	+4	+1	+2	+5	−4
North Platte, Nebr	0	−1	0	0	−3	−1	0	+1	+4	+7	+4	+1	+2	+1	−1
Denver, Colo	+2	−1	−3	−1	0	−1	+1	+3	+4	+6	+4	+1	+2	+5	−2

Dodge, Kans	− 1	− 1	− 3	− 3	− 1	+ 4	+ 5	+ 4	+ 8	+ 8	+ 3	0	+ 1	+ 3	− 2
Abilene, Tex	− 5	0	− 3	+ 1	− 2	+ 4	+ 5	+ 8	+10	+ 7	+ 5	0	0	+ 3	− 2
Santa Fe, N. Mex	− 2	− 1	− 3	− 1	+ 2	− 1	+ 1	+ 2	+ 6	+ 9	+ 3	− 1	+ 4	+ 6	− 2
El Paso, Tex	− 3	0	− 1	− 2	0	− 1	0	+ 4	+ 6	+ 7	+ 3	+ 1	0	+ 4	− 4
Phœnix, Ariz	+ 5	+ 3	+ 1	− 3	+ 3	− 4	0	− 3	+ 2	+ 8	+ 2	+ 4	+ 7	+11	+ 3
Pacific Coast:															
Seattle, Wash	− 2	− 3	+ 4	0	+ 7	+ 1	− 3	− 4	− 6	+ 1	+ 2	+ 3	+ 6	+ 5	+ 5
Portland, Oreg	− 3	− 4	+ 3	− 3	+ 5	+ 1	− 6	− 7	− 7	− 2	+ 1	+ 3	+ 7	+ 5	+ 4
Roseburg, Oreg	− 2	− 4	+ 2	− 3	+ 3	0	− 6	− 7	− 7	− 2	− 1	+ 4	+ 7	+ 5	+ 3
Red Bluff, Cal	+ 2	0	− 1	+ 2	− 2	− 7	− 9	−10	− 5	− 5	+ 1	+ 7	+10	+ 6	+ 8
Sacramento, Cal	+ 3	− 1	− 3	+ 4	− 3	− 6	− 6	− 6	− 2	− 4	0	+ 7	+ 9	+ 4	+ 7
San Francisco, Cal	− 1	− 2	− 4	− 1	− 2	− 1	0	0	+ 1	− 3	− 2	− 2	− 2	− 2	+ 9
Los Angeles, Cal	+ 3	+ 2	0	+ 1	− 1	− 1	− 2	− 4	− 2	+ 3	− 1	+ 3	+ 4	+ 3	+ 5
San Diego, Cal	− 2	0	− 3	− 1	− 2	− 2	− 4	− 5	− 3	− 1	− 3	− 1	0	− 2	+ 2

Precipitation departures (inches and hundredths) for season of 1899 from normal, based upon observations for many years, by sections.

Sections.	From Jan. 1 to Apr. 3, inclusive.	For weeks ending—											
		April—			May—					June—			
		10.	17.	24.	1.	8.	15.	22.	29.	5.	12.	19.	26.
Middle and South Atlantic States	+2.40	+0.25	−0.59	−0.20	−0.42	−0.20	−0.08	−0.55	−0.31	−0.14	−0.42	−0.32	−0.57
Gulf States	−2.66	− .09	− .79	+ .03	−1.01	− .11	+ .05	− .82	− .49	− .83	+ .84	− .31	− .63
Ohio Valley and Tennessee	+ .68	+ .09	− .84	+ .15	− .58	+ .05	.00	− .27	− .69	+ .08	− .12	− .65	− .23
Lake region	−1.12	− .30	− .40	− .48	− .10	− .23	− .24	− .11	+ .30	+ .24	− .35	− .45	− .67
Upper Mississippi and Missouri valleys	− .96	− .38	− .56	+ .04	+ .03	+ .24	+ .24	+ .72	+ .36	+ .32	+ .33	+ .31	− .43
Rocky Mountain region	+ .06	− .01	− .17	− .15	− .15	− .13	− .17	+ .02	+ .04	+ .16	+ .39	− .27	− .01
North Pacific coast	−1.62	− .56	+ .78	− .30	+ .25	− .20	+ .11	+ .12	+ .42	+ .17	− .26	− .31	− .03
California	− .85	− .46	− .41	− .26	− .02	− .22	− .19	− .15	+ .02	+ .61	− .07	− .05	+ .01

Sections.	For weeks ending—														
	July—					August—				September—				October—	
	3.	10.	17.	24.	31.	7.	14.	21.	28.	4.	11.	18.	25.	2.	9.
Middle and South Atlantic States	−0.54	+0.60	−0.59	−0.31	+0.56	−0.43	−0.10	−0.45	+0.10	+0.30	−0.78	−0.26	−0.07	−0.01	+0.57
Gulf States	+ .62	− .25	− .60	+1.81	+ .82	− .48	− .78	− .28	− .40	+ .03	− .48	− .66	− .74	− .77	− .20
Ohio Valley and Tennessee	− .72	− .53	− .21	+ .48	+ .46	+ .49	.00	− .68	− .53	− .10	− .05	− .66	− .20	− .42	− .19
Lake region	.00	+ .71	+ .18	− .29	− .39	− .20	− .06	− .43	− .42	− .48	− .18	− .46	+ .43	− .04	− .57
Upper Mississippi and Missouri valleys	− .17	+ .06	− .10	− .47	− .27	+ .43	+ .33	− .31	− .17	− .54	− .19	− .24	− .44	− .58	− .54
Rocky Mountain region	+ .10	− .16	+ .19	+ .33	+ .02	+ .31	− .20	− .28	− .18	− .12	− .02	− .03	− .25	− .27	− .21
North Pacific coast	− .03	− .14	− .15	+ .07	− .06	− .07	+ .97	+ .57	+ .54	+ .11	− .09	− .16	− .48	− .02	− .62
California	− .02	.00	.00	.09	.00	.00	.09	+ .01	.00	− .03	− .04	− .06	− .10	− .14	− .16

Precipitation departures (inches and hundredths) for season of 1899, from normal, based upon observation for many years, by stations.

Stations.	From Jan. 1 to Apr. 3, inclusive.	For weeks ending—											
		April—			May—					June—			
		10.	17.	24.	1.	8.	15.	22.	29.	5.	12.	19.	26.
New England:													
Eastport, Me	+0.29	—0.15	—0.59	—0.63	—0.51	—0.05	—0.63	+1.02	+0.10	—0.66	—0.25	+0.32	—0.60
Portland, Me	+2.51	+ .39	— .48	— .62	— .58	— .61	— .72	— .42	— .83	— .78	— .54	— .56	— .39
Boston, Mass	+1.10	— .04	— .26	— .77	— .83	— .47	— .62	— .60	— .77	— .73	— .08	— .21	— .11
Middle Atlantic States:													
Albany, N. Y	+ .94	— .11	— .37	— .59	— .22	+ .05	— .37	— .18	— .21	— .77	— .81	— .82	+ .07
New York City	+4.13	+ .12	— .48	— .77	— .77	— .43	— .14	— .55	— .68	— .63	— .67	— .26	— .11
Philadelphia, Pa	+6.54	— .05	— .31	— .70	— .70	— .70	+ .52	— .09	— .37	— .60	— .38	— .59	— .30
Washington, D. C	+3.84	+ .11	— .20	— .74	— .72	— .50	+ .14	+ .20	— .90	— .01	— .30	— .69	— .16
Lynchburg, Va	+8.34	+ .47	— .73	— .77	— .60	+ .23	— .31	— .59	— .63	+ .91	+ .61	+ .39	— .35
Norfolk, Va	+2.03	+ .36	— .90	— .91	— .38	— .54	— .26	— .85	— .54	+1.25	+1.94	— .74	— .98
South Atlantic States:													
Charlotte, N. C	+2.97	+ .93	— .71	— .78	— .21	+ .41	— .22	— .92	—1.03	— .51	— .27	— .56	—1.08
Wilmington, N. C	—4.10	+ .72	— .61	+1.33	+ .31	+1.38	— .34	— .94	+ .27	+ .34	—1.13	— .66	— .03
Charleston, S. C	—2.36	+ .78	— .82	+ .51	— .17	— .69	+ .89	— .78	+ .26	—1.01	—1.24	— .17	— .01
Augusta, Ga	+4.96	+ .34	— .52	— .69	— .48	— .63	— .77	— .71	+ .84	— .73	— .08	+1.39	—1.12
Savannah, Ga	+2.55	— .19	— .84	— .33	— .38	— .23	— .02	— .57	— .72	— .82	—1.52	—1.14	—1.61
Jacksonville, Fla	— .99	— .53	— .63	+1.97	— .71	— .75	— .08	— .94	+ .04	+1.09	—1.21	+ .33	—1.15
Gulf States:													
Atlanta, Ga	— .91	+ .17	— .80	— .32	— .62	— .53	— .43	— .33	— .82	— .36	— .41	— .81	— .68
Mobile, Ala	—1.97	—1.00	— .94	— .64	— .88	— .91	— .88	— .98	— .54	— .60	+2.88	—1.36	— .19
Montgomery, Ala	—3.71	— .69	—1.08	+ .82	—1.04	— .94	— .66	— .88	+ .58	—1.03	— .74	— .91	— .35
Vicksburg, Miss	+1.87	+ .15	—1.40	—1.06	—1.27	—1.19	—1.11	—1.10	— .81	— .27	+1.98	+ .75	— .82
New Orleans, La	—7.34	— .82	—1.13	— .10	—1.18	—1.09	—1.05	—1.06	—1.17	—1.19	+2.95	—1.00	+ .27
Shreveport, La	—5.24	+ .11	—1.16	— .53	—1.13	—1.00	+1.50	— .91	— .76	— .91	— .88	— .08	— .79
Fort Smith, Ark	—4.30	— .76	— .74	+1.11	—1.14	+4.64	— .08	— .54	— .34	— .54	+3.77	— .64	— .98
Little Rock, Ark	—4.35	— .17	— .60	+ .69	—1.20	— .37	— .26	— .27	+1.35	—1.18	— .55	— .94	— .89
Palestine, Tex	—1.85	+ .80	— .96	— .21	—1.20	— .77	+2.94	—1.35	—1.28	—1.21	— .30	— .57	— .87
Galveston, Tex	+3.88	+ .93	+ .09	— .23	— .70	— .73	— .81	— .89	—1.00	—1.11	— .52	— .83	—1.04
San Antonio, Tex	—5.29	— .23	+ .02	+ .76	— .77	— .48	+1.14	— .66	— .70	— .70	+1.09	+1.92	— .56
Ohio Valley and Tennessee:													
Memphis, Tenn	—4.00	— .49	—1.15	— .85	—1.25	+ .23	+ .80	— .76	— .18	— .01	— .26	— .81	+ .30
Nashville, Tenn	+2.99	+ .53	—1.12	+ .32	— .94	+ .80	+ .24	— .12	— .77	— .89	— .98	— .96	— .98
Chattanooga, Tenn	+7.75	+ .58	—1.04	+3.16	— .80	— .72	— .41	— .36	— .90	— .33	+ .86	— .91	— .75
Louisville, Ky	+ .36	+ .04	—1.07	+ .67	— .32	— .06	+ .07	+ .21	— .85	— .31	+ .99	— .29	— .14
Indianapolis, Ind	— .74	— .55	— .77	— .23	— .59	+ .29	— .43	— .56	— .77	+ .65	— .84	— .92	— .42
Cincinnati, Ohio	+ .55	+ .01	— .76	— .70	— .35	+ .23	+ .72	— .77	— .77	+1.15	.00	— .82	+ .66
Columbus, Ohio	—1.84	— .11	— .55	— .54	— .63	+ .08	— .45	— .94	— .69	+ .03	— .76	— .69	— .25
Pittsburg, Pa	+ .51	+ .69	— .30	— .66	+ .20	— .45	— .50	+ .94	— .57	+ .32	+ .05	+ .18	— .27
Lake region:													
Oswego, N. Y	+1.74	+ .69	— .05	— .42	— .48	— .44	+ .21	+ .29	+ .45	+ .21	— .72	+ .29	— .70

Buffalo, N. Y	−1.05	− .25	− .38	− .56	− .64	− .42	+ .03	− .33	− .59	+ .89	− .82	− .60	− .79
Cleveland, Ohio	− .70	− .14	− .20	− .49	− .35	− .36	− .53	+ .09	+ .06	− .25	− .54	− .53	− .85
Detroit, Mich	+1.47	− .36	− .44	− .36	− .45	− .10	− .40	+ .06	− .26	− .57	+ .10	− .63	− .72
Grand Haven, Mich	−2.07	− .56	− .45	− .55	+1.19	− .58	− .16	− .45	+1.10	+ .32	− .83	− .94	− .87
Milwaukee, Wis	−3.56	− .61	− .48	− .70	− .24	− .29	+ .06	− .69	+ .67	− .05	+ .23	− .91	− .49
Chicago, Ill	−2.86	− .68	− .66	− .65	− .76	+ .61	− .41	− .58	+ .77	+ .26	− .03	− .23	− .89
Duluth, Minn	−1.90	− .48	− .56	− .12	+ .96	− .29	− .68	+ .16	+ .22	+1.07	− .16	− .08	− .02
Upper Mississippi Valley:													
St. Paul, Minn	+1.19	− .49	− .53	− .53	+ .82	− .54	− .70	− .17	+1.21	+1.51	+ .74	+1.54	− .81
La Crosse, Wis	− .55	− .47	− .39	− .31	+2.03	+ .67	− .66	+ .44	+1.31	+1.71	+5.01	+1.44	−1.04
Davenport, Iowa	−1.45	− .59	− .21	+ .10	+ .95	− .24	+1.35	− .38	+2.53	+ .10	− .88	+ .21	+ .43
Des Moines, Iowa	−2.10	− .42	− .63	− .54	+ .84	+ .39	+ .67	+1.17	− .17	− .78	−1.33	− .01	− .47
Springfield, Ill	−1.14	− .79	− .77	− .22	− .99	+1.16	− .20	+1.99	+2.49	+ .88	+ .07	− .45	− .95
Cairo, Ill	− .13	+ .06	− .81	+ .26	− .79	+1.13	+ .96	+ .16	− .77	− .31	+ .41	+2.65	−1.04
St. Louis, Mo	+ .51	− .32	− .86	+ .54	− .95	+ .63	+ .60	+1.54	−1.06	− .62	− .18	− .50	− .78
Missouri Valley:													
Springfield, Mo	−4.33	− .25	+ .16	+2.20	−1.14	+1.12	+2.09	−1.25	−1.15	− .18	+ .86	+ .89	− .19
Kansas City, Mo	− .04	+ .16	− .68	+1.37	− .36	− .67	+ .06	+1.31	−1.12	+ .79	+ .50	− .48	− .96
Concordia, Kans	−1.01	− .05	− .43	− .50	− .54	− .54	− .01	+ .88	+1.17	+ .61	+ .97	− .92	+ .10
Omaha, Nebr	−1.68	− .49	− .73	− .69	+ .50	+ .68	− .38	+ .49	− .26	− .20	−1.02	+ .80	+ .12
Valentine, Nebr	− .51	− .58	− .68	− .70	+ .11	− .45	− .45	+ .29	+ .82	+ .03	− .48	− .63	+ .40
Huron, S. Dak	− .20	− .65	− .70	− .50	− .03	+ .34	− .22	+ .43	− .35	+ .76	− .41	− .50	− .45
Extreme Northwest:													
Moorhead, Minn	− .05	− .23	− .44	− .14	+ .86	− .20	− .36	− .48	+1.68	+ .18	− .32	− .66	− .82
Bismarck, N. Dak	−1.23	− .42	− .42	+ .50	− .51	+1.46	− .31	− .50	+1.36	+2.26	− .69	− .05	+ .29
Williston, N. Dak	− .09	− .25	− .22	+ .04	− .34	+ .12	− .40	− .42	+ .05	+2.18	− .07	− .76	− .25
Rocky Mountain Slope:													
Havre, Mont	+ .50	− .20	− .17	+ .12	− .10	+3.02	− .29	+ .22	+ .79	+ .06	− .45	− .56	+ .07
Helena, Mont	+ .63	− .23	− .22	+ .35	− .24	− .14	− .23	+1.21	− .42	.33	− .55	− .38	− .50
Spokane, Wash	+ .67	+ .18	.00	− .16	+ .05	− .23	.00	− .20	− .06	+ .02	− .38	.42	− .12
Salt Lake City, Utah	+2.27	− .54	− .54	− .35	− .25	+ .27	− .23	+ .10	+ .38	+1.06	− .21	− .16	− .08
Cheyenne, Wyo	+3.21	− .11	− .29	− .35	+ .33	− .24	− .52	+ .70	− .28	.07	− .31	− .30	− .15
North Platte, Nebr	− .49	− .45	− .53	− .56	+ .26	+ .14	− .50	+ .45	+1.07	− .75	− .73	− .20	+ .25
Denver, Colo	+ .30	− .03	− .45	− .53	− .38	− .55	− .70	− .63	− .57	− .42	+ .13	− .28	− .30
Dodge, Kans	−1.38	− .06	− .35	− .41	− .17	− .54	+ .14	− .36	− .68	+2.17	+6.70	− .77	− .15
Abilene, Tex	−3.11	+ .33	+ .39	+ .37	− .77	+ .23	+ .74	− .81	+ .64	+ .35	+ .45	+ .02	− .72
Santa Fe, N. Mex	.06	.03	.03	.17	− .21	.21	.25	− .28	− .22	− .17	− .14	− .18	+ .83
El Paso, Tex	−1.06	+ .67	+ .19	− .04	− .07	− .07	− .09	− .14	− .14	− .09	+ .20	− .05	+ .18
Phenix, Ariz	− .79	− .07	− .07	− .07	− .07	− .07	− .07	− .01	.00	+ .14	.00	.00	+ .58
Pacific Coast:													
Seattle, Wash	−2.40	− .44	+1.49	− .45	− .25	− .37	+ .21	+ .28	− .13	+ .06	+ .04	− .19	− .04
Portland, Oreg	−5.81	− .58	+ .85	− .28	+ .38	− .36	+ .37	− .02	+ .44	+ .25	− .48	− .44	− .09
Roseburg, Oreg	+3.34	− .56	− .01	− .16	+ .61	− .18	− .26	+ .10	+ .94	+ .20	− .35	− .31	+ .03
Red Bluff, Cal	+3.63	− .56	− .51	− .46	+ .28	− .36	− .33	− .28	+ .31	+ .71	− .14	− .11	+ .08
Sacramento, Cal	− .18	− .56	− .56	− .51	− .33	− .32	− .18	− .19	− .10	+ .82	− .07	− .05	+ .04
San Francisco, Cal	− .38	− .55	− .49	− .01	− .10	− .27	− .21	− .14	+ .03	+ .70	− .07	− .07	− .05
Los Angeles, Cal	−4.90	− .41	− .31	− .17	− .10	− .10	− .11	− .07	− .07	+ .50	− .04	.00	.00
San Diego, Cal	−2.42	− .21	− .20	− .14	+ .15	− .05	− .09	− .07	− .05	+ .28	− .03	− .03	.00

Precipitation departures (inches and hundredths) for season of 1899 from normal, etc.—Continued.

Stations.	For weeks ending—														
	July—					August—				September—				October—	
	3.	10.	17.	24.	31.	7.	14.	21.	28.	4.	11.	18.	25.	2.	9.
New England:															
Eastport, Me	−0.26	+0.51	−0.56	+1.00	+0.29	−0.84	−0.63	−0.77	−0.38	−0.44	−0.65	−0.76	+0.72	−0.59	+0.37
Portland, Me	− .56	− .01	− .62	− .25	+1.68	− .53	+ .01	− .84	− .41	− .05	− .48	− .48	+1.66	+ .20	− .73
Boston, Mass	+ .36	+ .28	− .69	− .76	+ .58	− .92	− .14	−1.03	+ .52	− .38	− .65	− .34	+2.36	+ .58	− .10
Middle Atlantic States:															
Albany, N. Y	− .24	+ .02	− .45	− .87	+ .40	− .02	− .54	− .91	− .45	− .31	− .43	− .78	+ .40	+3.45	− .77
New York City	− .12	+1.64	+1.19	− .16	− .37	+ .23	+1.12	−1.04	− .78	+2.24	− .81	+ .10	+ .56	− .54	− .10
Philadelphia, Pa	− .71	+ .17	− .83	− .98	+2.52	+ .51	+1.85	− .98	− .16	− .86	− .34	− .32	+ .86	+ .45	+ .03
Washington, D. C	− .94	+ .63	+ .38	− .61	+1.50	+ .68	− .21	+ .01	− .41	− .78	− .84	− .23	+1.74	+2.06	+ .64
Lynchburg, Va	− .04	+ .81	− .77	− .43	+ .62	+ .86	+ .13	+1.47	+1.22	− .43	+ .15	− .75	+1.42	− .07	+1.16
Norfolk, Va	− .79	+ .42	− .75	− .71	+1.48	−1.13	−1.24	+ .81	−1.31	−1.19	− .99	− .98	− .89	− .91	+ .40
South Atlantic States:															
Charlotte, N. C	−1.17	+ .10	−1.17	−1.00	+3.00	−1.26	− .45	−1.22	+2.54	− .43	+ .46	− .72	− .37	− .49	+2.08
Wilmington, N. C	− .17	+1.13	−1.63	+1.61	+ .33	+ .54	−1.08	− .34	− .55	− .97	−1.56	−1.51	−1.39	−1.28	− .15
Charleston, S. C	− .86	− .20	−1.49	+ .62	−1.15	−1.81	−1.45	− .44	+ .39	+3.47	−1.61	−1.12	− .59	− .98	+ .04
Augusta, Ga	− .10	+ .60	−1.19	− .37	− .06	− .98	+3.00	−1.19	− .36	+1.31	+ .08	− .95	− .57	− .61	+2.41
Savannah, Ga	−1.23	+1.54	− .01	− .80	− .93	−1.68	− .66	− .57	+1.82	+1.47	−1.54	+2.64	−1.21	−1.19	+ .56
Jacksonville, Fla	− .05	+ .33	− .33	− .02	− .58	−1.14	− .62	−1.09	− .60	− .07	−2.01	+1.54	− .80	−1.43	+ .68
Gulf States:															
Atlanta, Ga	− .40	+ .27	−1.12	+3.15	− .33	−1.12	−1.02	− .96	− .32	+1.34	+ .96	− .88	− .75	− .49	+2.16
Mobile, Ala	−1.34	− .71	−1.03	+1.21	+4.38	−1.00	− .39	− .05	− .95	− .91	− .93	−1.20	− .38	− .99	− .47
Montgomery, Ala	− .52	− .75	− .33	+9.12	+1.30	+ .76	− .98	+ .64	+1.49	+1.40	− .49	− .70	− .21	− .61	+1.49
Vicksburg, Miss	− .38	− .83	−1.05	+ .47	− .09	+2.01	− .79	+ .14	− .69	+ .27	+ .50	− .87	− .55	− .63	− .48
New Orleans, La	− .43	− .47	−1.27	− .88	+1.96	−1.33	−1.25	− .24	− .52	−1.04	−1.09	− .85	−1.02	− .91	− .74
Shreveport, La	− .42	− .19	− .83	− .74	− .63	− .52	− .39	− .31	− .43	− .29	− .85	− .64	− .80	− .80	− .70
Fort Smith, Ark	− .76	− .14	− .90	+3.11	− .92	− .87	− .26	− .27	− .84	− .84	− .81	− .53	− .83	− .75	− .67
Little Rock, Ark	− .53	+ .40	− .47	+4.45	− .68	− .92	− .89	− .96	+ .79	− .81	+ .61	+ .72	− .69	− .59	− .52
Palestine, Tex	+8.17	− .03	− .13	+1.17	− .25	− .56	− .59	+ .66	− .63	− .13	− .76	− .49	− .77	− .75	− .70
Galveston, Tex	+2.76	− .67	+ .16	− .68	+4.28	−1.05	−1.20	− .76	−1.38	+2.33	−1.52	−1.51	−1.38	−1.25	−1.05
San Antonio, Tex	+ .65	− .18	+ .37	− .50	.00	− .73	− .84	− .93	− .95	− .87	− .87	− .29	− .74	− .62	− .47
Ohio Valley and Tennessee:															
Memphis, Tenn	− .89	− .06	− .77	+2.21	+1.36	− .65	− .59	− .09	+ .03	− .67	− .53	− .64	− .55	− .62	− .58
Nashville, Tenn	− .42	− .97	− .94	+3.65	+ .84	+ .53	− .67	− .66	− .76	+ .15	− .23	−1.02	− .63	− .35	− .28
Chattanooga, Tenn	−1.06	− .52	− .93	+ .79	− .82	− .59	− .85	− .83	− .63	+1.09	− .26	− .91	− .45	− .47	+1.68
Louisville, Ky	− .95	− .73	− .20	+ .08	− .43	+ .53	+ .50	− .80	− .76	− .70	− .32	− .67	− .15	− .55	− .52
Indianapolis, Ind	− .92	− .93	+ .12	− .97	+1.58	+2.79	+1.45	− .70	− .70	− .20	+ .36	− .27	− .14	− .58	− .59
Cincinnati, Ohio	− .83	+ .03	− .15	− .74	− .61	+1.14	+ .65	− .86	− .67	− .73	+ .93	− .55	+ .03	− .39	− .46
Columbus, Ohio	− .77	− .27	+1.34	− .41	+1.30	+ .46	− .55	− .76	− .61	− .16	− .48	− .63	+ .54	− .33	− .52
Pittsburg, Pa	+ .08	− .75	− .16	− .79	+ .50	+ .43	+ .03	− .70	− .10	+ .39	+ .13	− .61	− .23	− .01	− .28
Lake region:															
Oswego, N. Y	− .53	+ .24	− .53	− .28	− .55	− .32	− .37	− .56	− .30	− .23	− .52	− .63	− .31	+1.95	− .47

Buffalo, N. Y	.63	+ .15	.13	.00	.28	.04	.18	.70	.59	.31	.12	.66	+ .44	+ .61	— .67
Cleveland, Ohio	.18	+ .75	+1.15	.74	.35	— .10	— .70	— .70	— .62	— .74	— .82	— .84	+ .32	— .38	— .10
Detroit, Mich	.31	+ .16	— .08	+ .12	— .53	.28	.65	.63	.31	— .11	.47	.33	+ .83	— .29	.53
Grand Haven, Mich	.15	+1.41	+ .03	— .32	+ .04	— .28	— .46	— .60	— .65	— .71	+ .47	— .44	+1.42	— .72	— .77
Milwaukee, Wis	— .19	+ .53	— .49	— .15	.59	+ .59	+ .57	— .59	— .63	— .60	.39	— .03	+1.37	— .58	— .54
Chicago, Ill	+ .05	+2.37	+2.16	— .77	— .50	.09	.40	.65	.63	.67	.32	+ .02	+ .26	.19	.70
Duluth, Minn	+2.20	— .23	— .36	— .51	— .31	— .36	+2.03	+ .96	+ .32	— .45	+ .66	— .71	— .87	— .75	— .67
Upper Mississippi Valley:															
St. Paul, Minn	.37	.54	.08	— .28	— .57	— .46	— .33	— .13	— .19	+ .46	— .05	— .55	— .59	— .61	— .51
La Crosse, Wis	+ .11	— .95	+2.03	— .38	— .74	— .17	+ .39	+ .07	+ .34	.71	— .35	— .73	— .42	.86	.63
Davenport, Iowa	.55	+ .45	+ .44	— .84	— .74	+2.13	+ .03	— .53	— .36	— .77	— .55	.27	.60	.68	— .63
Des Moines, Iowa	+1.28	+ .67	.59	— .77	— .23	+1.41	+ .17	— .69	— .17	— .70	— .35	— .77	— .01	— .70	— .70
Springfield, Ill	— .34	+ .39	— .51	— .56	— .38	+1.16	+1.31	— .03	.57	.67	+ .49	+ .53	.15	— .52	.64
Cairo, Ill	.78	.07	.76	+2.03	.36	— .21	— .63	— .01	— .63	— .63	+ .66	+ .09	— .26	— .60	— .56
St. Louis, Mo	.90	+ .73	+ .53	— .71	— .42	+ .78	+ .48	— .55	— .77	— .77	.50	+ .13	.54	— .70	— .67
Missouri Valley:															
Springfield, Mo	— .85	— .53	—1.06	.78	— .43	— .88	— .61	— .81	— .57	— .91	— .91	— .04	— .95	— .83	— .71
Kansas City, Mo	—1.09	+3.00	+ .30	— .91	— .57	+ .85	+ .15	— .88	+1.56	— .84	+ .34	— .31	— .77	— .77	— .77
Concordia, Kans	—2.18	— .64	— .12	.70	+1.18	— .48	+1.06	— .63	+ .21	— .59	+ .50	— .13	— .56	— .47	— .18
Omaha, Nebr	— .26	—1.06	— .47	— .98	— .17	+1.69	+2.67	— .74	— .55	— .63	— .38	.70	— .45	— .63	— .54
Valentine, Nebr	— .04	— .65	— .14	— .50	— .19	+ .13	+ .30	+ .31	— .19	— .13	— .25	— .21	— .21	— .21	— .13
Huron, S. Dak	— .54	— .05	— .45	— .70	— .70	— .39	— .60	+ .67	— .33	— .07	— .36	— .09	— .28	— .29	— .26
Extreme Northwest:															
Moorhead, Minn	+ .48	+ .65	— .21	— .86	— .67	— .67	— .13	+1.86	— .56	— .50	— .45	+ .15	— .43	+ .30	— .49
Bismarck, N. Dak	+ .04	— .58	— .52	— .46	— .33	— .18	— .39	+ .16	— .42	— .36	— .29	— .24	— .24	— .21	— .28
Williston, N. Dak	— .14	+ .83	— .40	— .27	— .07	+ .09	— .18	— .25	— .16	— .21	— .21	— .21	— .16	— .09	— .21
Rocky Mountain Slope:															
Havre, Mont	— .29	— .40	— .20	+ .04	— .04	+1.88	— .18	— .14	+ .35	— .13	— .28	— .16	— .28	— .22	— .10
Helena, Mont	.38	— .20	— .24	+ .14	— .02	+ .26	+ .33	— .12	+ .24	+ .33	— .28	— .17	— .28	— .24	— .18
Spokane, Wash	— .14	— .12	— .18	— .10	+ .08	— .01	+ .21	+ .20	+ .63	+ .14	+ .12	+ .19	— .28	— .26	— .35
Salt Lake City, Utah	— .13	— .14	+ .19	— .02	— .09	+ .92	— .14	— .14	— .21	— .21	— .21	— .21	— .21	— .27	— .35
Cheyenne, Wyo	— .09	+ .42	+ .69	— .42	+ .76	+ .22	— .26	— .25	— .33	+ .10	— .15	— .21	— .21	— .19	— .16
North Platte, Nebr	+ .08	— .64	— .39	— .39	+ .40	+ .24	+ .10	— .55	— .54	— .05	— .05	— .24	— .28	— .28	— .22
Denver, Colo	+ .02	+ .28	+ .23	— .40	— .12	+1.33	— .35	— .35	— .32	— .14	— .21	+ .04	— .14	— .21	— .21
Dodge, Kans	+ .35	— .68	+ .65	+2.37	+ .47	— .47	— .67	— .66	— .40	— .31	+ .72	+ .27	— .28	— .28	+ .12
Abilene, Tex	+2.25	— .40	— .31	+ .34	— .31	— .52	— .61	— .53	— .63	— .63	— .56	— .12	— .56	— .56	— .56
Santa Fe, N. Mex	— .23	— .21	+2.25	+ .70	— .70	— .54	— .66	— .53	— .34	— .37	+ .05	+ .63	— .25	— .31	— .20
El Paso, Tex	— .18	+ .16	— .28	+1.23	+ .01	— .07	+ .13	— .42	— .38	— .31	+ .36	— .28	— .24	— .21	— .20
Phenix, Ariz	— .07	— .03	— .11	+ .43	— .24	+ .43	— .27	— .03	— .18	— .06	+ .23	— .14	— .11	— .18	— .10
Pacific Coast:															
Seattle, Wash	+ .08	— .09	— .21	— .10	— .05	— .14	+1.05	+ .61	+ .42	+ .11	— .47	+ .08	— .63	— .15	— .63
Portland, Oreg	— .16	— .18	— .14	+ .39	— .07	— .07	+ .26	+ .83	+1.02	+ .14	+ .09	— .34	— .50	+ .20	— .70
Roseburg, Oreg	— .21	— .14	— .09	— .07	— .07	.00	+1.59	+ .28	+ .17	+ .08	+ .12	— .22	— .31	— .12	— .54
Red Bluff, Cal	— .07	.00	.00	.00	.00	+ .02	.00	.00	.00	— .06	— .11	— .16	— .21	— .21	— .26
Sacramento, Cal	.00	.00	.00	.00	.00	+ .02	.00	.00	.00	— .04	— .07	— .07	— .08	— .14	— .14
San Francisco, Cal	— .02	.00	.00	.00	.00	.00	.00	.00	.00	— .01	.00	— .07	— .10	— .16	— .21
Los Angeles, Cal	— .02	.00	.00	.00	.00	+ .01	.00	.00	.00	— .03	.00	.00	— .03	— .07	— .14
San Diego, Cal	.00	.00	.00	.00	— .01	— .07	— .05	+ .07	.00	.00	.00	.00	— .06	.00	— .04

PROGRESS IN AGRICULTURAL CHEMISTRY IN 1899.

As often happens, a large part of the work of this field has been of such a nature that no immediate results could be expected. In all parts of the world contributions have been made to agricultural chemistry during the past year which do not seem of sufficient general value to merit mention in a paper of this nature, but which will serve to make up data essential to generalizations that may follow in the near future. As an illustration, a vast array of digestion experiments may be cited, as well as the chemical examination of soils, irrigation waters, foods, and feeding stuffs.

The subject of the application of nitrifying organisms to the soil has received an increased amount of attention, and while the results of many experiments would seem to be conclusive, it can not be said that a marked advance has been made. It is well known that such an application is of value to soils on which a stand of a leguminous plant could not be otherwise secured, but much remains to be done in determining the classes of soils to which ferments may be added with advantage, and the particular ferment which is essential to each plant.

It has long been held that the ordinary complex nitrogenous compounds of the soil are changed successively into ammonia, nitrous acid, and nitric acid. Within the last year it has also been shown that even the simplest amins, when subjected to the action of soil ferments, are never oxidized to nitrous or nitric acid without the formation of ammonia as a preliminary product.[1]

Experiments made on the conservation of manures,[2] indicate that greater loss takes place in storing acid manures than those whose reaction is alkaline. In the former case the loss is due to the liberation of free nitrogen owing to the reaction of nitrites with amido or ammonium compounds, while some ammonia is given off by alkaline manures.

Pot experiments with soils show that a reduction in yield follows the application of coarse straw and manure. It has been held that this was due to that change in the physical nature of the soil caused by the coarse texture of the material employed. Recent experiments,[3] however, indicate that the reduction in yield is due to the supplying of a favorable medium for the denitrifying organisms already present in the soil. The grinding of the straw and manure did not tend to reduce the action of the denitrifying organisms. Pentosans were found to promote the development of these organisms more than cellulose. Ordinary variations of the water content of the soil did not appreciably affect denitrification, but a high water content seemed to favor it. It is not believed that much importance is to be attached to denitrification resulting from this cause in the field.

Contrary to the commonly accepted theory, humus, obtained from soil and peat, has been found to be comparatively free from amids.[4] Evidence has also been offered in support of the view that humus is capable of decomposing minerals and insoluble salts.[5]

Experiments[6] published during the year seem to indicate that the availability of the phosphoric acid of certain phosphates is due to the action of silicic acid. These acids always exist together in soluble form, and the amounts of the two are somewhat, though not regularly, proportional. It is suggested that phosphoric acid goes into solution on account of the more or less complete precipitation, either as carbonate or humate, of the calcium with which it is originally combined, and the consequent combination of phosphoric acid with ammonia or other alkalies. This takes place most readily in phosphates whose lime is most loosely combined, such as superphosphates and Thomas slag.

The investigation of peaty soils has been continued. One sample,[7] whose phosphoric acid content was 0.38 per cent, contained 0.05 per cent of free phosphoric acid, and 0.13 per cent combined with humus. Only insignificant amounts of lecithin were present.

The percentage of chlorin in the ash of the tobacco plant[8] has been found, generally speaking, to be roughly proportional to that of the chlorin in the soil, and inversely proportional to the percentage of nitrates in the soil. The chlorin occurs in greatest abundance in the leaves and is combined almost entirely with potassium and sodium, potassium chlorid largely predominating.

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[1] E. Demoussy, Ann. agron., 1899, **25**, 232–244.

[2] G. Marpmann, C. B. Bakt. Par., 1899, **2**, 67–70.

[3] Kruger and Schneidewind, Landw. Jahr., 1899, **28**, 217–252.

[4] F. Sistini, Landw. Versst., 1899, **51**, 153–158.

[5] P. Lyashchenko, Selsk, Kohz. i Lyesov, 1899, **193**, 718, through Exp. Sta. Record, 1899, **11**, 623.

[6] W. Hoffmeister, ibid., 1899, **52**, 329–346.

[7] G. Nannes, J. Landw., 1899, **47**, 45–48.

[8] P. Pichard, Cr., 1899, **128**, 615–617.

The cause of the reduction in the yield of starch when potatoes are fertilized with crude Stassfurt salts [1] has been studied further, and the theory that injurious effects were due to the chlorin contained in the crude salts is fully confirmed. In comparative experiments with potassium fertilizers containing chlorin and those free from it, the latter were found to increase both the percentage of starch and the yield of tubers and to be entirely free from the injurious effects of the former. It is suggested that potatoes take up more potash in the form of chlorid than in any other combination, and that the potassium chlorid content of the tubers interferes with the formation of starch.

Some attention has been given to the injurious effects suffered by soils that have been overflowed by sea water.[2] In addition to the salt that is left behind, the layer of mud that is deposited is said to prevent the washing out of the sodium chlorid and interfere with the germination of the seed.

In a large number of laboratories an extensive study of the composition of soils has been made. Of much of this work it can only be said at present that the literature of the subject has been increased. Many of the analyses were connected with extensive plans of fertilization, crop rotation, or irrigation. In some cases they form a part of the survey of a large section of the country. Many agricultural laboratories, both in this country and abroad, have conducted work of this nature.

Analytical methods have been criticised, and some new methods and important modifications of old ones have been devised. As illustrations, two methods [3] may be cited which have been suggested for estimation of the carbon dioxid combined with lime, without including that of the carbonate of iron. In this connection may also be mentioned valuable contributions that have been made to the literature of methods for the determination of the productiveness of soils.[4]

The study of the effect of special fertilization and culture on the composition of seeds has received considerable attention. It has been found that the fertilization of rape [5] for a large yield (with phosphoric acid) produces a seed with a relatively high percentage of fat and low percentage of proteids. Maize [6] has also been found to be susceptible of improvement in its composition, by means of seed selection. Thus, it is possible to grow a product rich in starch or in proteids as may be desired. It is claimed that this cereal may be roughly graded with respect to its proteid and fat content by the naked eye, since the percentage of proteids varies with the thickness of the glutinous layer, and that of the fat with the size of the germ.

The water supply and water content of the soil has received the usual amount of attention at home and abroad. A study has been made [7] of the relation between the fertilizer and water content of the soil, and the amount of water removed therefrom by oats under varying water and fertilizer content of the soil. In this work it was found that the water supplied could be more completely utilized the larger the application of fertilizers, and that a liberal application of fertilizers requires a large amount of water. With an insufficient water supply, however, a heavy application of fertilizers was found to make the soil solution too concentrated and cause a reduction of the yield. The application of salts, which caused deleterious changes in the composition of the fertilizing ingredients of the soil, was found to affect the water supply unfavorably. At the same time, experiments are described [8] which seem to disprove the theory that the applications of fertilizers to soils retards the loss of moisture by evaporation and drainage.

The study of the Australian salt bush and its value as a stock food, as well as its power of resisting alkali and drought, has been continued in California.[9] This work confirms the experience of preceding years in approving of the plant as a forage plant to be raised in alkaline soils. A number of other drought and alkali-resisting plants have also been described,[10] and their value as forage plants discussed.

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[1] Johann. Wilms., J. Landw., 1899, **47**, 251–292. B. Sjollema, ibid., 305–309.

[2] A. J. Swaving, Landw. Versst., 1899, **51**, 463–471.

[3] Adolf Mayer, ibid., 1899, **51**, 339–340. Stutzer and Hartleb, Mitt. Landw. Inst., Breslau, 1899, 101–105, abs. Exp. Sta. Record, 1899, **11**, 110.

[4] W. W. Winner, Izv. Moscow, Selsk. Inst., 1899, 5, 117–144, through Exp. Sta. Record, **11**, 623.

[5] Wilh. Grashoff, J. Landw., 1899, **47**, 85–90.

[6] C. G. Hopkins, Ill. Exp. Sta. Bull., No. 55.

[7] C. v. Seelhorst, J. Landw., 1899, **47**, 369–378.

[8] Willard and Clothier, Kan. Exp. Sta. Bull., No. 89.

[9] M. E. Jaffa, Cal. Exp. Sta. Bull., No. 125.

[10] Alven Nelson, Wyoming Exp. Sta. Bull., No. 42.

The chemistry of the changes of nitrogenous compounds during the germination of the seed and the growth of the plant has received careful attention.[1] The following is given as a summary of our information on this subject at the present time: (1) The process of proteid decomposition occupies a long period, and may be characterized by a peculiar curve. (2) The accumulation of asparagin is characterized by a similar curve, whose maximum is identical with that of the first-mentioned curve. (3) Both curves attain their maxima a few days before the evolution of carbon dioxid takes place. (4) At the end of the period of germination the rate of the formation of asparagin exceeds that of the decomposition of proteid, some asparagin being formed from amido compounds. (5) Proteids may be formed in the dark from carbohydrates and amido compounds, but not from asparagin. (6) Proteids are decomposed as rapidly in seeds germinating in the light as in those germinating in the dark. (7) The formation of proteid begins with the unfolding of the leaves—in some plants in ten days after germination, in others later. (8) Proteids are formed simultaneously from asparagin and other amido compounds, or from the latter first and then the former, but never the reverse. (9) The most energetic regeneration of proteids occurs in seeds.

Recent work in the study of the vegetable proteids[2] has led to the conclusion that the protein bodies hitherto prepared are in fact definite chemical compounds of protein substances with common mineral acids, or contain such compounds in admixture. It is also found that egg albumen prepared by the usual process contains two distinct substances.

Some very extensive work has been done on the chemistry of butter fat,[3] a series of samples of butter made from a herd of high-grade Guernseys being taken as the basis of the work. Attention has been given to the physical and chemical constituents of the substance, its chemical composition, and the chemistry of its rancidity. This work is of such a nature as not to permit an abstract, but adds materially to our information on the subject. In point of scientific value, it will doubtless take a high rank in the chemical work of the year.

BEET SUGAR.

The attention of the laboratories of a large number of the agricultural experiment stations, especially of the Northern States, has been occupied a part of the year with sugar beets. While it can not be said that any new information has been gained by this work, a large number of analyses have been made, and the data accumulated are undoubtedly of value.

The importance that is attached to this work by the capitalists of the country is indicated by the number of beet-sugar factories that have been completed in the United States during the year 1899, in time to be operated during the beet season of 1899 and 1900, as well as the number building for the season of 1900-1901.

Beet-sugar factories built in 1899.

Company.	Location.	Capacity. *a*
Spreckels Sugar Co	Spreckels, Cal	3,000
American Beet Sugar Co	Oxnard, Cal	2,000
Union Sugar Co	Santa Maria, Cal	600
Colorado Sugar Manufacturing Co	Grand Junction, Colo	350
Illinois Sugar Co	Pekin, Ill	700
Bay City Sugar Co	Essexville, Mich	600
West Bay City Sugar Co	West Bay City, Mich	500
Alma Sugar Co	Alma, Mich	500
Kalamazoo Sugar Co	Kalamazoo, Mich	500
Wolverine Sugar Co	Benton Harbor, Mich	500
Holland Sugar Co	Holland, Mich	350
Detroit Sugar Co	Rochester, Mich	500
Peninsula Sugar Refining Co	Caro, Mich	600
Standard Beet Sugar Co	Ames, Nebr	600
Utah Sugar Co	Springville, Utah (auxiliary to Lehi)	350
Washington State Sugar Co	Waverly, Wash	350

a Quantity of beets ground daily when running full time expressed in tons of 2,240 pounds.

[1] D. N. Prianischnikow, Landw. Versst., 1899, **52**, 137-165 and 347-382.
[2] T. B. Osborne, J. Am. Chem. Soc., 1899, **4**, 477-495.
[3] C. A. Browne, jr., J. Am. Chem. Soc., 1899, **21**, 612-633, 807-827, and 975-994.

Factories building for campaign of 1900–1901.

Company.	Location.	Capacity. *a*
American Beet Sugar Co	Rocky Ford, Colo	1,000
National Beet Sugar Co	Sugar City, Colo	500
Continental Sugar Co	Fremont, Ohio	400
Empire State Sugar Co	Lyons, N. Y	500
Utah Sugar Co	Bingham Junction, Utah (auxiliary to Lehi).	350

a Quantity of beets ground daily when running full time expressed in tons of 2,240 pounds

THE PRINCIPAL INJURIOUS INSECTS OF THE YEAR 1899.

THE AMERICAN LOCUST (*Schistocerca americana* Dr.).—The American grasshopper or locust appeared in great numbers in portions of Georgia and Mississippi, and did considerable damage to corn and small grains, and in cotton fields.

THE APPLE APHIS (*Aphis mali* Fab.).—Many cases of injury by this common apple pest were reported in various portions of the country, and in particular in Pennsylvania, District of Columbia, North Carolina, Georgia, Iowa, Washington, and Arizona.

THE APPLE-TREE TENT CATERPILLAR (*Clisiocampa americana* Harr.).—The apple-tree tent caterpillars were more abundant than in several years in New York and New Hampshire.

ASPARAGUS BEETLES (*Crioceris asparagi* Linn.; *C. 12-punctata* Linn.).—These two species continued their spread northward and westward, although no serious injury has yet been reported in the new localities which they have invaded.

THE BEAN LEAF-BEETLE (*Cerotoma trifurcata* Forst.).—This leaf-beetle did considerable damage to beans in Virginia, Maryland, Alabama, and Missouri; an attack was noticed also in Illinois.

THE BLACK APHIS OF VIOLETS (*Rhopalosiphum violæ* Perg.).—This, one of the most destructive insects in violet greenhouses, was reported as in previous years to be injurious in several localities in New York, Maryland, and Canada, in the last-mentioned locality being reported by Dr. James Fletcher.

THE BLACK GOOSEBERRY BORER (*Xylocrius agassizii* Lec.).—This new pest of the gooseberry was reported to have done injury to the stems of this fruit in British Columbia, where it was found in stock recently introduced from Oregon.

THE BOLL WORM; CORN-EAR WORM (*Heliothis armiger* Hbn.).—In Georgia the boll worm was more than usually destructive to tomatoes, beans, and sweet corn. It also did extensive damage to beans in Mississippi. Farther north it was less injurious than in many years.

THE BRONZE APPLE-TREE WEEVIL (*Magdalis ænescens* Lec.).—Injury by this new enemy to the fruit industry of the Pacific States was reported in portions of Washington and Oregon to apple trees of all ages.

THE CABBAGE CURCULIO (*Ceutorhynchus rapæ* Gyll.).—This enemy to young cabbage plants was troublesome in the vicinity of Racine, Wis., and was found in the greatest abundance in the District of Columbia.

THE CHERRY FRUIT FLY (*Trypeta cingulata* Loew.).—This fruit fly was found to be very injurious to cherries in various parts of New York the past spring.

THE CHINCH BUG (*Blissus leucopterus* Say).—An outbreak of the chinch bug in northern Ohio has been described by Professor Webster.

THE CLOVER-LEAF WEEVIL (*Phytonomus punctatus* Fab.).—Extremely abundant in the District of Columbia.

THE COLORADO POTATO BEETLE (*Doryphora 10-lineata* Say).—The "Colorado potato bug" attracted more attention than for several years past. Professors Slingerland and Quaintance report it as being more than usually common in New York and Georgia. Professor Johnson did not find it as abundant as usual in Maryland.

THE COMMON STRAWBERRY LEAF-ROLLER (*Phoxopteris comptana* Froel.).—This common leaf-roller occurred in abundance in the District of Columbia and Maryland during the last season, and was reported to have been troublesome also in Iowa and Illinois.

THE COMMON SQUASH BUG (*Anasa tristis* DeG.).—The squash bug continued its depredations on cucurbits, and has been especially destructive in Georgia. Dr. Felt has recorded it as abundant in parts of New York. Correspondents have reported injury also in Mississippi, Wisconsin, and Virginia.

THE DESTRUCTIVE GREEN PEA LOUSE (*Nectarophora destructor* Johns.).—This plant-louse, new to economic science, attracted much attention along the northern Atlantic section of our country. Recorded from Virginia to New Brunswick, it was especially injurious in Maryland, where Professor Johnson reports its damage to acres of peas.

THE EUROPEAN ORCHARD SCALE (*Aspidiotus ostreæformis* Curtis).—The discovery of this well-known European scale in various parts of our country has been recorded by Mr. Marlatt of the Division of Entomology. As yet, it has been found only in the northern portions—New York, Michigan, and Idaho; and in Canada.

THE FALL ARMY WORM OR GRASS WORM (*Laphygma frugiperda* S. and A.).—The fall army worm appeared in unusual numbers during the year throughout a considerable extent of the eastern United States, from central New York and northern Illinois to Florida and Georgia, and westward to Kansas. The species was particularly destructive to the rice and corn fields of the South, to small grains, grasses, and lawns northward, and to a great variety of garden crops in all sections. The same insect was reported as damaging tobacco in Cuba.

THE FOREST TENT CATERPILLAR (*Clisiocampa disstria* Hbn.).—The northeastern portion of the country again suffered severely from the ravages of the forest tent caterpillar.

THE FRUIT-TREE BARK-BEETLE (*Scolytus rugulosus* Ratz.).—The fruit-tree bark-beetle was observed injuring the peach and other fruit trees in Michigan, Georgia, Pennsylvania, Ohio, Indiana, Virginia, West Virginia, and Maryland.

THE GRAPE ROOT-WORM (*Fidia viticida* Walsh.).—This insect continued its depredations, according to Messrs. Webster and Mally, in northern Ohio.

THE GREENHOUSE LEAF-TYER (*Phlyctænia rubigalis* Guen.).—This destructive greenhouse pest, though not so troublesome as in previous years, was still of some importance as a depredator upon violets in Maryland and Virginia, and to other greenhouse plants in New York and Canada.

THE HARLEQUIN CABBAGE BUG (*Murgantia histrionica* Hahn).—This, one of the worst enemies of cruciferous crops, was less troublesome northward than for a number of years. It was, however, locally abundant in certain localities in Maryland and Georgia.

THE HESSIAN FLY (*Cecidomyia destructor* Say).—The ravages of the Hessian fly attracted attention in Ohio, New York, Michigan, and Minnesota, yet without instances of great severity. In Maryland it was reported as very abundant on early sown wheat.

THE IMBRICATED SNOUT-BEETLE (*Epicærus imbricatus* Say).—Injury by this beetle to fruit-trees in Texas and Oklahoma was reported. Attack was noticed in Maryland, but the species was rarer in its northern range than in former years.

THE IMPORTED CABBAGE WEBWORM (*Hellula undalis* Fab.).—This cabbage webworm, an important insect new to economic entomology, and of recent importation into the United States, was reported during the year as having done considerable damage to cabbage, turnip, and other cruciferous crops in portions of Georgia, South Carolina, and Alabama.

THE IMPORTED CABBAGE WORM (*Pieris rapæ* Linn.).—This species was quite troublesome to young cabbage in Maryland and Virginia early in the season, but was controlled by parasites later. It was troublesome during the year in Georgia, Alabama, California, Illinois, North Carolina, and the District of Columbia.

THE IMPORTED CURRANT WORM (*Pteronus ribesii* Scop.).—This introduced pest was abundant and injurious in Maryland, Virginia, and Kentucky.

THE IMPORTED ELM LEAF-BEETLE (*Galerucella luteola* Müll.).—The elm leaf-beetle has been recorded as very abundant in Massachusetts by Professor Kirkland, in New York by Dr. Felt, and in Maryland by Professor Johnson.

THE LARGER CORN STALK-BORER (*Diatræa saccharalis* Fab.).—This cornstalk-borer has been recorded as abundant in parts of South Carolina, Georgia, and Alabama, but was rare farther southward.

THE MEDITERRANEAN FLOUR MOTH (*Ephestia kuehniella* Zell.).—This moth was a conspicuous mill pest in California, Pennsylvania, New York, Ohio, and Canada. Late in the previous year it was reported in a new State, Minnesota.

THE MELON PLANT-LOUSE (*Aphis gossypii* Glov.).—Professor Johnson reports that the melon plant-louse ruined hundreds of acres of melons in Maryland. Professor Quaintance recorded its abundance in Georgia.

THE NEW YORK WEEVIL (*Ithycerus noveboracensis* Forst.).—During the year this species effected injury to apple and peach trees, as reported by Professor Quaintance in Georgia, and by a correspondent of the Division of Entomology in Virginia.

THE OBLIQUE-BANDED LEAF-ROLLER (*Cacœcia rosaceana* Harr.).—This common enemy of rosaceous plants was observed by Messrs. Chittenden and Pratt in great numbers in different localities in Maryland, and an attack was reported by Dr. James Fletcher in greenhouses in Canada.

THE ONION THRIPS (*Thrips tabaci* Lind.).—The onion thrips continues to be a subject for investigation in several States, Michigan and Georgia being notably affected, while it was also recorded from Ohio, Florida, and New York.

THE PALE-STRIPED FLEA-BEETLE (*Systena blanda* Mels.).—Injury by this species was noticed by a correspondent in Michigan, and it was reported by Professor Johnson as troublesome in Maryland. Damage was severe to sugar beets, to Kieffer pear grafts and to tomatoes. Attack was also noticed on beans.

THE PEAR-TREE PSYLLA (*Psylla pyricola* Forst.).—The pear-tree Psylla has, according to Professor Johnson, been unusually abundant in Maryland pear orchards.

THE PICKLE WORM (*Margaronia nitidalis* Cram.).—The pickle worm was very destructive to cucurbits in Georgia.

PINE BARK-BEETLES (*Dendroctonus* spp.).—Extensive damage was done to coniferous forests in the Northwest by species of this genus of destructive bark-boring beetles.

THE PLUM CURCULIO (*Conotrachelus nenuphar* Hbst.).—The plum curculio was reported by Professor Quaintance as ovipositing in apples, currants, and salmon berries in Georgia. In Maryland Professor Johnson states that it did much injury to the peach crop.

THE PLUM MOTH (*Grapholitha prunivora* Walsh.).—This insect which is somewhat of a pest farther north, was abundant in Maryland near the District line, attacking and destroying both plums and apples.

THE PURPLE SCALE (*Mytilaspis citricola* Pack.).—The purple scale of the orange seems to have gained a firm foothold in southern California, and during the past season there was considerable alarm among the orange growers of that State. A State employee, Mr. George Compere, was sent to Hawaii to collect specimens of a Coccinellid beetle, which Californians hope may reduce the scale insect to insignificant numbers.

THE ROCKY MOUNTAIN LOCUST (*Melanoplus spretus* Thos.).—There was some hatching of the destructive Western grasshopper or migratory grasshopper in North Dakota during the present season, and a large swarm was observed flying over that portion of the country.

THE ROSE-CHAFER (*Macrodactylus subspinosus* Fab.).—Professor Webster, of Ohio, claims to have found a valuable remedy for the rose-chafer. One-half pound of fish-oil soap dissolved in a gallon of water and sprayed upon them will kill 95 per cent.

THE SALT-MARSH CATERPILLAR (*Leucarctia acræa* Dru.).—This was one of the commonest caterpillars in the District of Columbia, Maryland, and Georgia during the year, attacking cabbage, beans, peas, and various other garden crops.

THE SAN JOSE SCALE (*Aspidiotus perniciosus* Comst.).—The San Jose scale continues to occupy a prominent place in the list of insect pests. Notable remedial work was performed both in Maryland, where Professor Johnson exterminated it with hydrocyanic-acid gas, and in New Jersey, where Professor Smith used crude petroleum against the scale.

THE SEVENTEEN-YEAR CICADA (*Cicada septendecim* Linn.).—Brood XIX of the Seventeen-year Cicadi made its appearance in western New York.

THE SMALLER CORN STALK-BORER (*Elasmopalpus lignosellus* Zell.).—This stalk-borer was reported for the first time since 1881 as injurious in the Southern States. It was destructive to beans and peanuts in Alabama, Georgia, and South Carolina.

THE SOOTY CORN-ROOT WEBWORM (*Crambus caliginosellus* Clem.).—Professor Johnson has recorded a new and remarkable habit of the corn Crambus in infesting the stalks of tobacco. It was also abundant on lawns in the District of Columbia.

THE SQUASH-VINE BORER (*Melittia satyriniformis* Hbst.).—The squash-vine borer was reported in injurious numbers from Georgia and Ohio. It was abundant in some localities in Maryland, but occurred so late as to do little injury as compared with former years.

THE STRIPED BLISTER BEETLE (*Epicauta vittata* Fab.).—This blister beetle was very abundant in New York on potatoes, according to Dr. Felt. Professor Webster says that more complaints than usual were received of its ravages in Ohio, while Professor Johnson recorded it as especially numerous on potatoes, tomatoes, cabbage, and beets in Maryland.

THE STRIPED CUCUMBER BEETLE (*Diabrotica vittata* Fab.).—The striped cucumber beetle was reported as doing much damage in Georgia, Maryland, and Indiana.

THE TARNISHED PLANT-BUG (*Lygus pratensis* Linn.).—Professor Stedman has reported on the damage by the tarnished plant-bug in Missouri. Professor Johnson recorded it as sucking the buds of pear and plum trees in Maryland; he used a spray of 15 per cent solution of kerosene and water successfully. Professor Webster recorded it as injurious to peach buds in Ohio.

THE VIOLET SAWFLY (*Emphytus canadensis* Kby.).—This sawfly was reported by Dr. James Fletcher to have been destructive in violet greenhouses at Toronto, Canada.

THE WALNUT HAND-MAID MOTH (*Datana integerrima* G. & R.).—The caterpillar of this destructive forest insect was reported to have done extensive injury to different species of forest, shade, and fruit trees by defoliation in Ohio, North Carolina, Maryland, and the District of Columbia.

THE WESTERN CORN ROOT-WORM (*Diabrotica longicornis* Say).—During the season this species was injurious in Nebraska and Ohio, and was reported to be increasing in the severity of its attack in both States.

THE WESTERN GREEN JUNE BEETLE (*Allorhina mutabilis* Gory).—This southwestern species of June beetle was stated by a correspondent to have been injurious to a considerable number of fruits in southern Arizona.

THE WHITE-MARKED TUSSOCK-MOTH (*Orgyia leucostigma* S. & A.).—In Baltimore, Md., this tussock-moth was unusually troublesome on shade trees.

WINGLESS MAY BEETLES (*Lachnosterna farcta* Lec., and *L. lanceolata* Say).—The two species of wingless May beetles above mentioned were injurious to collards in Texas.

THE WOOLLY BEAR (*Spilosoma virginica* Fab.).—The woolly caterpillars of this moth were very injurious to onions in both Georgia and Massachusetts as reported by Professor Quaintance and Professor Kirkland.

PROGRESS IN FRUIT GROWING IN 1899.

In the absence of statistics on the subject, it is safe to say in a general way the year 1899 was a fairly prosperous one in fruit growing. Where crops were short many valuable lessons resulted in experiences gained of certain peculiarities of the season.

A prominent fruit grower in southern Michigan, whose motto has been "Thorough Culture," reaped a rich harvest from his peach crop, though the widespread and unusual cold wave of February, 1899, had destroyed the peach buds, not only of his vicinity, but of nearly the whole peach belt from the Rocky Mountains to the Atlantic seaboard. The exception in his case was doubtless due to the fact that his trees were in complete health, full of vigor, and constant care and continuous culture prepared them for the trying ordeal through which they passed. This fact is suggestive.

Another peculiarity of the past season was the long-continued and universally prevalent droughts. Here, also, is found a valuable lesson on culture. An intelligent fruit grower of Connecticut, who has more than once pronounced blessings on the San Jose scale, curculio, and codling moth, inasmuch as they have no terrors for him, but assist him in securing a monopoly of the best markets, claims the drought is a blessing in disguise, as he meets it in an intelligent way that is sure to bring satisfactory rewards for his perseverance. It is sufficient to say he does not "wait for rain" before ordering his cultivators into the field.

Pomology not being an exact science, it is impossible to make a definite statement of the progress made during a given time; but it is safe to say that no single year in the history of fruit growing in the United States has shown greater progress in the production of new varieties as well as in methods of culture, care of trees, plants, and vines and the management and marketing of fruit products.

The production of new and desirable varieties is an art rapidly approaching the conditions of a true science. While it is a fact that many valuable discoveries in this line have been the result of accident, we are not content to longer trust to chance for valuable results. Fruit growers are learning to combine the good qualities of both parents in the improvement of pomological offspring, as is done in the breeding and improvement of domestic animals. Very great skill and scientific knowledge is required in the line of plant breeding in order to obtain anything like satisfactory results. From this cause the successful and continuous production of desirable new varieties will forever belong, as it now does, to the intelligent, painstaking few. No mere bungler or novice can expect to attain satisfactory results in this line of work. The creation and introduction of new and promising varieties of fruits is not the work of a given period of time, as, for instance, a calendar year, but more properly a series of years, in which to test their qualities under the varying conditions and vicissitudes of climate, etc. A variety must be pretty thoroughly tested by the above standard before it can be safely given out as beyond doubt an acquisition.

In this connection it is admissible to refer to a series of interesting experiments being made by Prof. H. J. Webber, of the Division of Physiology and Pathology, in the production of hybrids of the hardy orange, *Citrus trifoliata*, crossed with the common sweet orange. These experiments are now well under way, many promising plants having already been produced, from which it is hoped to obtain fruit in the near future. It is hoped that varieties may thus be obtained that are of fine quality and sufficiently hardy to greatly extend the limit of practical orange growing.

The successful introduction into California of the blastophaga during the past year by the Department of Agriculture, greatly encourages the hope of success in producing the true Smyrna fig. Great anticipation is now centered in the successful wintering of the colony of insects established during the past year at Fresno. If they should come out all right in the spring and follow their natural instincts, as in their native home of Smyrna, the successful pollination of the Smyrna fig in California is almost assured.

The export trade in apples, while not as large as that of 1896–97 (the largest ever known by more than 1,500,000 barrels), shows an increase over the year 1897–98 of almost a half a million barrels. Great Britain is the best export market for the apple, and there is an increasing demand for the apple in the German Empire.

The shipments of deciduous fruits from California shows an increase of 37 per cent over the year 1898. The total for the year was 7,500 carloads. California produced 14,000,000 pounds of almonds, equaling one-third of the home consumption.

The best paying fruit crop on the Delaware peninsula in 1899 seems to have been the Kieffer pear.

Florida produced about $300,000 worth of cocoanuts.

RECENT PROGRESS IN ROAD BUILDING.

The Maryland highway division of the State geological survey, since its creation by the legislature in 1898, has made a careful inquiry into the road question of the State. Its report sets forth the need of better roads, and gives suggestions as to the manner in which this result may be most quickly and acceptably brought about. The document takes up the question of road legislation and shows how much money could be saved by putting the roads in good condition; which amount is estimated at $3,000,000 per annum. The total mileage of public roads in Maryland is placed at 14,483, or about 1.47 miles to each square mile of territory. This amount includes toll roads which are owned by 51 companies, the combined length of such roads being 497 miles. Over 13,000 miles of Maryland roads are composed of earth, 890 miles are built of stone, 225 miles of gravel, and 250 miles of shells. There are 2,021 miles of highways in the State that are classed as main roads.

Governor Stone, of Pennsylvania, has recently appointed a special commission to investigate the road subject of the State and to present a bill to the next legislature which, in the opinion of the commission, will best meet the demands for a change in the present system of road building. The commission consists of A. J. Cassatt, president of the Pennsylvania Railroad; ex-Governor Beaver, John P. Elkin, attorney-general of the State; H. B. Breckenridge, of Leetonia, and H. C. Snavely, of Lebanon.

A report comes from Allegheny County, Pa., that 25 miles of road were opened, improved, and dedicated to the public during the calendar year 1898, and during the past year the amount has been increased to 50 miles. These roads have been macadamized and given subdrainage and surface drainage. The width of the main roads is about 33 feet, and they traverse populous rural districts. The average cost per mile for road improvement in Allegheny County is about $6,000. About 85 miles of roads are either contracted for or are now undergoing improvements.

The legislature of New York is being strongly urged to appropriate $1,000,000 this year for the improvement of State roads. Massachusetts appropriates one-half million dollars annually for the same purpose, while New Jersey spends $150,000, and will this year probably increase that amount to $200,000.

The toll roads of Kentucky are being bought up and made free as fast as possible. These turnpikes are turned over to the counties in consideration of a payment of from $75 to $250 per mile. Some of them, however, are given to the counties without any consideration whatever. Shelby County has recently bought up 117 miles of turnpike, at a total cost of about $15,000, and these roads were made free on January 1, 1900. It has been estimated that nine-tenths of the roads of Kentucky are still worked in the old-fashioned way by forced labor. Each man living on the farm, between the ages of 18 and 50, is compelled to work the road or pay someone else to do so. This system very rarely results in good roads, as a large portion of the work injures rather than benefits them. The feeling is growing in Kentucky that the existing method compels too small a portion of the citizens to bear the burden of improving all the roads of the State, and a movement is now on foot to secure a more uniform system of taxation by passing a State-aid law. The same condition exists in Virginia, where the State-aid sentiment is also becoming very strong. A State-aid measure is also to be presented to the legislature of Ohio, and will stand a fair chance of becoming a law.

In Georgia road improvement is making a steady march. In the vicinity of Athens over six miles of roads have been, in the last six months, thoroughly graded and several very steep hills have been thrown out. The work has been done at a very small expense to the county, the excavation and removal of earth costing not more then 10 cents per cubic yard.

A long step toward better roads was taken in Tennessee by the adoption of a new road law. This law, in effect January 1, 1900, differs from the old law in that it requires the election of only one road commissioner for each county, who is to have charge and oversight of all roads and bridges in the county. Under the old law a commissioner was elected for each civil district. All highways in the State are now to be worked by contract, sealed proposals for which are submitted on or before the first Monday in January of each year. The main highways are to be constructed according to correct and high standard specifications, avoiding heavy grades and reducing some by cutting down steep portions or changing the direction of the road where advisable. Bradley County, Tenn., is to have a hundred miles of new stone roads, having recently borrowed money for the purpose. The construction of the main road from Cleveland to Mahan Gap has already been begun; hills are being leveled or skirted, hollows filled, and stone culverts and framework for bridges built. It is thought that 100 miles of stone and gravel roads will be completed in Bradley County by the end of the calendar year 1900.

The commissioner of highways of Connecticut estimates that 500 miles of roads have been completed since the State-aid system was adopted. The improvement of several hundred more miles is in progress or has been projected.

State Commissioner of Highways Viall, of Vermont, states that more miles of roads have been built during the last year than during the whole period from 1892 to 1898. One hundred and seventeen miles of road were built during the calendar year 1899, and at this rate, if it continues, the commissioner says that the main thoroughfares of the State will be made permanent within a few years.

The people of Columbia, S. C., have come to realize the necessity of good roads as well as the importance of building them in the best and most economical way through the medium of good-roads machinery. A road-building plant has recently been purchased at an expense of about $6,000, which includes a fine rock-crushing plant, a large and a small steam roller, big plows, road machines, etc. The rock-crushing plant turns out about 60 tons of stone daily.

A few years ago the legislature of California passed a wide-tire law, which went into effect January 1, 1900. Several defects have been pointed out in the law, and it is quite probable that it will become a dead letter on the statute books.

At East Hampton, N. Y., the women have taken a hand in the building and maintenance of the public highways, and for this use $1,551.50 has been turned into the treasury of the Ladies Village Improvement Society during the past season.

Considerable interest has been recently taken in the use of crude petroleum in improving the surfaces of common earth roads. The press has given the idea a wide circulation, and experiments are being made throughout the country. The advocates of this system claim that when a road is properly treated with oil the result is a dustless and nonabsorbent surface, which will turn rain water and furnish a dark-colored roadbed, which is more pleasing to the eye than the ordinary light, dusty soil; also that an oiled road will be free from grass or weeds. The present methods of oiling the roads are yet in the experimental stage.

PLANT DISEASES IN THE UNITED STATES IN 1899.

DISEASES OF FRUIT, SHADE, AND OTHER TREES.

With a few exceptions, the prevalence of fruit diseases in the United States in 1899 did not vary greatly from what has been noted for previous years. Fruit trees throughout the country were in many cases severely injured by the extreme cold of the winter, and, while in many instances they recovered remarkably well, yet a number were killed outright and some were so badly injured that they succumbed later. Some were so slightly affected that the injury was not very apparent, but in many cases such trees will inevitably sooner or later become affected with some of the more common diseases. Peaches and, to a lesser extent, other fruit trees were so injured that they bore no fruit. Pear blight was very prevalent during the year, causing much damage in the Le Conte pear region of the South, and was reported for the first time as doing considerable injury on the Pacific coast.

Apples were remarkably free from diseases of all kinds throughout the South, but in the Northern Pacific States a disease known as black canker caused great injury. Where the lines of treatment recommended by the Department were carried out, however, the latter disease seemed to be controlled.

Peach yellows still continues to do injury, notably in the region near the Atlantic coast. In Michigan the disease has been brought largely under control by rigid inspection of orchards and the destruction of diseased trees as soon as discovered. A new disease, known as little peach, has recently appeared in the peach orchards of Michigan, and is also known to occur in New York and Delaware. Peach-leaf curl has been more or less prevalent throughout the Pacific coast region, as well as in the East. The application during the year of sprays recommended by the Department has resulted in controlling the disease wherever the treatment was properly made.

Black rot, anthracnose, and other diseases of the grape prevailed more or less, but in most cases they were held in check where proper treatment was carried on. The California vine disease caused considerable alarm in parts of central and northern California, and experiments having for their object the discovery of resistant varieties are now being carried on and show encouraging results.

In the subtropical fruit-growing region, notably in Florida, freezes injured the young orange trees despite the strenuous efforts made by the growers to protect them by means of sheds, tents, etc. Pineapples have been injured by a number of diseases, especially by blight, but where careful attention is given to selecting healthy slips this disease may be in a measure controlled.

Various trees planted for shade or ornament have been affected with the usual diseases which prevail to a greater or less extent every year, depending much on climatic conditions. In cities especially shade trees are apt to suffer during even moderate droughts, and there were many complaints, resulting from local causes of this kind, during the year.

DISEASES OF SMALL FRUITS.

Anthracnose of the raspberry and blackberry and strawberry leaf blight were abundant, although not more so than in previous years.

DISEASES OF COTTON, VEGETABLES, AND CEREALS.

Cotton was considerably injured by a disease known as wilt, which has spread over large areas of the sea island region and has also done considerable damage in the upland districts. Anthracnose and rust of cotton also caused severe damage in several localities. Watermelons were injured by the wilt, but where the recommendations of the Department with reference to rotation of crops and the use of fresh land were followed the disease was held in check.

The leaf spot of muskmelons was exceedingly abundant, especially in the Central States and the Rocky Ford, Ga., melon district. Tomatoes were injured by the leaf blight (Septoria), which must now be regarded as a serious factor in connection with the growing of this crop in the Central States and to some extent elsewhere. The bacterial diseases of cabbage, and of the tomato, eggplant, and Irish potato were about as abundant as usual, but did not do great damage except in limited localities. The various grain rusts and smuts were not more destructive than usual, although prevalent to a considerable extent.

STATE STANDARDS FOR DAIRY PRODUCTS, 1900.

The following table shows the requirements for articles sold under the names specified. States not named have no laws prescribing standards for dairy products:

[Prepared by Dairy Division, B. A. I.]

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. c. fat. Half skim, 15 p. c. fat. Skim, from skim milk.
Colorado	....	....	....	....	....	....	35 p.c. total solids, fat.
Dist. of Columbia	....	9	3.5	9.3	20	83 Not over 12 p. c. water or 5 p.c. salt	
Georgia	....	8.5	3.5				
Illinois[1]	12	....	3	....	15[2]	80	48 p.c. total solids, fat.
Indiana	....	9	3	....	....	80	10 p. c. milk-fats.
Iowa	12.5	....	3	....	15		
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.c. total solids to be fat
Missouri	....	....	....	....	....	....	From milk testing at least 3 p. c. fat.
New Hampshire	13						
New Jersey	12						
New York[3]	12	....	3				
North Dakota	12	....	3	....	15		
Ohio[3]	12	....	3	1	1	80	20 p. c. fat.
May and June	11.5						
Oregon	12	....	3 12 p. c. cream by vol.	sp. grav 1.035	....	Not over 14 p. c. water.	
Pennsylvania (Milk and skim-milk standards refer to cities of second and third class.)	12.5 Sp. grav. 1.029-33	....	3	2.5 p. c. fat. 6 per c. cream by vol. sp. grav 1.032-37	....	....	Full cream, 32 p. c. fat. Three-fourths cream, 24 p. c. fat. One-half cream, 16 p. c. fat. One-fourth cream, 8 p. c. fat. Skim'd, below 8 p. c. fat.
Rhode Island	12	....	2.5				
South Carolina	....	8.5					
Utah	....	....	....	9 p. c. solids not fat			
Vermont	12.5	9.25					
May and June	12						
Washington	....	8	3	....	....	....	Full cream, 30 p. c. fat. Skimmed, 15 p. c. fat.
Wisconsin	....	....	3				

[1] Condensed milk shall be made from milk containing at least the legal standard of 3 p. c. butter fat, and evaporated to one-third or less of its original volume.
[2] Coffee cream shall contain at least 15 p. c. of fat, and whipping cream 22 p. c. fat.
[3] Milk solids of condensed milk shall be in quantity the equivalent of 12 p. c. of milk solids in crude milk, of which solids 25 p. c. shall be fat.

PROGRESS IN FORESTRY DURING 1899.

Advancement in forestry during the past year is observable both in the direction of growth of public sentiment and in that of specific legislative and executive action.

In May, 1898, an important increase in the appropriation of Congress for the administration of the Federal forest reserves enabled the Secretary of the Interior to place in the field a more nearly adequate forest service. The forest ranger system as it now exists may hopefully be regarded, subject, of course, to important elaboration and extension, as the first step toward a scheme of forest protection that promises to be substantially effective. In the suppression and avertance of forest fires the present system has already shown encouraging results.

Since September, 1898, seven new reserves have been added. These are the Trabuco Canyon and the Fish Lake reserves, the Gallatin reserves, the Gila River, Lake Tahoe, Santa Inez, and Prescott reserves, with a total acreage of 5,250,136 acres. The Mount Rainier Reserve, originally created by President Cleveland, has been reduced by 207,360 acres, which have been set aside to form the Mount Rainier National Park.

The United States Geological Survey is steadily pursuing its all-important work of surveying, describing, and mapping the lands included in the reserves. The work of mapping has progressed in the Flathead and Lewis and Clarke reserves of Montana, the Priest River and Bitter Root reserves of Idaho, the Cascade Reserve of Washington, and the Uintah Reserve of Utah.

The examination of the forests of the reserves and adjacent regions has, during the past season, been completed in the Mount Rainer Reserve of Washington; has been continued in the Olympic Reserve, nearly completing that valuable forest region; has been commenced in the Cascade Reserve of Oregon, and the reserves of the Sierra Nevada of California. The work of estimating the supply of standing timber, which was completed for the State of Washington last year, has been continued into Oregon, and most of the stand of that State has been secured. It has been continued in California, with the prospect of completing that State during the coming year. Similar estimates are being made for the States of the Great Lakes—Michigan, Wisconsin, and Minnesota—the work being carried on jointly by the Department of Agriculture and the Geological Survey.

General public interest in forestry has increased in a remarkable degree, shown by the attitude of the press and the favorable legislative action which has followed agitation among the States; New York, with its College of Forestry and management of the the college forest, both now well under way, under the direction of Dr. B. E. Fernow, takes, perhaps, the first rank. This year a further appropriation of $300,000 was made for additional purchases of forest land in the Adirondacks, bringing the whole amount expended for this purpose since the organization of the Forest Preserve Board in 1897 to a total of $1,800,000. Though the purchases are not yet completed, the figures contained in the last report of the board show a total area of lands in the Adirondacks reserved to the State amounting to something over 1,100,000 acres. More significant still, as marking the beginning of a distinct movement on the part of private owners of forest lands, is the work in private forestry, also in the Adirondacks, which has been regarded as satisfactory in the main, both by the persons interested and by the Division of Forestry, under whose guidance it has been carried on.

California, as usual, has been most active in all departments of forest agitation, and although comprehensive legislation failed of the governor's approval at the very close of the last session of the legislature, the intent of the plan was carried into operation by the forest organizations themselves. A noteworthy happening has been the offer of certain redwood manufacturers to furnish $1,000 in money, as well as to provide subsistence in their camps and transportation over their lines for the agents of the Division of Forestry, in order to hasten the time by a year when investigations on the growth and reproduction of the redwood could be begun. At the University of California a school of foresty may be established in the not distant future.

Pennsylvania also has made marked progress. Her forest-fire law has received a useful amendment. The commissioner of forestry has received added authority, conferring power to purchase lands for creating forest reservations whenever there are available funds in the treasury for that purpose. Under the safeguards provided there is no necessity for delay in awaiting special legislation for each new case of purchase. Finally, the commission authorized sometime since to select three tracts of land of at least 40,000 acres each, is about to take final action, and a recent communication from Dr. Rothrock states that within the next few months probably 200,000 acres of forest land will be reserved to the State of Pennsylvania.

Minnesota has been especially energetic, and has been fortunate in having the efforts of her own citizens, ably assisted by enthusiastic friends from other States, in the endeavor to induce Congress to set apart vast timber lands for a national park and forest reserve. A State board of forestry has been appointed, whose members have been chosen on a well-considered plan. The special points of this admirable act are its provisions for the acceptance by the board of lands granted, deeded, or devised to them for the purposes of forest reservations, and for the reinvestment of the moneys to be derived as revenue from the proposed management. Assurances have been given that gifts, under these provisions, amounting to thousands of acres, will very soon be made to the board. An executive committee has been chosen, composed of Captain Cross, president of the board; General Andrews, its secretary; and Professor Green. It took action at once to arrange for a visit of inspection of the Minnesota forests by Dr. C. A. Schenck.

Michigan has likewise created a permanent forest commission, with the commissioner of the State land office as ex officio member. The personnel of the commission, headed by Mr. Arthur Hill, a prominent lumberman, promises most favorably. The main provision of the act is that the governor appoints a State fire marshal, for a term of two years. The marshal appoints two deputies, one of whom shall reside in the upper peninsula; and in addition, city and town fire marshals throughout the State are made deputies. A bill to create the office of fire warden, with provisions based on the Massachusetts law of 1894, was introduced but failed of passage. Its supporters, however, have good hope of securing its enactment at the next session of the legislature.

What Minnesota has been attempting for the North and West, North Carolina is urging for the South, and for the seaboard States in general. A great national park is proposed for the crest of the Alleghenies, primarily for timber preservation.

Georgia has passed a significant amendment to her forest-fire law by which the setting of fire to woods willfully, carelessly, or negligently is now made a misdemeanor, whereas formerly malicious intent was specified, a provision which made the law inoperative from the difficulty of establishing proof. A number of other States stand in need of similar amendments before their statutes, long dead on the books, can be rendered effective.

Wisconsin has provided that forest wardens, formerly appointed in every organized town, are henceforth to be appointed in certain counties, while in the remaining counties they are to be appointed only on request of the supervisors.

In the matter of tree planting and conservation on a small scale, Indiana has passed a law offering partial remission of taxes on definite proportions of holdings covered with a specified number of forest trees per acre, either as virgin forest or as planted or partially planted to that number. Such areas are to be assessed at a valuation of $1 per acre.

Nebraska and Nevada have repealed their laws providing bounties for forest trees planted and cultivated. Like the bounty law of Pennsylvania, they have had small results because of the trivial inducement offered.

The legislature of North Dakota recently established a school of forestry, located at the village of Bottineau; and a bill has just been introduced in the United States Senate (Senate bill 158, December 6, 1899,) providing for the grant of 30,000 acres of public land, to be selected by the proper authorities of the State, to aid in the maintenance of the school. The bill has been twice read, and referred to the committee on public lands.

Forest reserves[1] of the United States, names, locations, areas, etc.

Numbers of— Reserves.	Numbers of— Proclamations.	States.	Names of reserves.	Present areas of reserves.	Dates of proclamations.	Areas of reserves.	Remarks.
			ADMINISTRATION OF PRESIDENT HARRISON.	*Acres.*		*Acres.*	
1, 2	1	Wyoming	Timber land reserve, Yellowstone Park	1,239,040	Mar. 30, 1891	1,239,040	Proclamation revised.
1, 2	2	do	do		Sept. 10, 1891		
3	3	Colorado	Timber land reserve, White River Plateau	1,198,080	Oct. 16, 1891	1,198,080	
4, 35	4	New Mexico	The Pecos River Forest Reserve		Jan. 11, 1892	311,040	See proclamation No. 35.
5, 6	5	Colorado	Timber land reserve, Pike's Peak	184,320	Feb. 11, 1892	184,320	Proclamation revised.
5, 6	6	do	do		Mar. 18, 1892		
7	7	Oregon	Timber land reserve, Bull Run	142,080	June 17, 1892	142,080	
8	8	Colorado	Timber land reserve, Plum Creek	179,200	June 23, 1892	179,200	
9	9	do	The South Platte Forest Reserve	683,520	Dec. 9, 1892	683,520	
10	10	California	Timber land reserve, San Gabriel	555,520	Dec. 20, 1892	555,520	
11	11	Colorado	Battlement Mesa Forest Reserve	858,240	Dec. 24, 1892	858,240	
12	12	Alaska	Afognak Forest and Fish Culture Reserve	403,640	do	403,640	Area, not official—estimated by planimeter on Coast and Geodetic map. Scale 1:1200000.
13	13	California	Sierra Forest Reserve	4,096,000	Feb. 14, 1893	4,096,000	
28, 14, 44	14	Washington	The Pacific Forest Reserve	967,680	Feb. 20, 1893	967,680	The title, "The Pacific Forest Reserve," was abolished February 22, 1897. The Reserve is now included in "The Mount Rainier Forest Reserve." See proclamation No. 28.
15	15	Arizona	Grand Canyon Forest Reserve	1,851,520	do	1,851,520	
16	16	California	San Bernardino Forest Reserve	737,280	Feb. 25, 1893	737,280	
17, 40	17	do	Trabuco Canyon Forest Reserve		do	49,920	See proclamation No. 40.
						13,457,080	
			ADMINISTRATION OF PRESIDENT CLEVELAND.				
18	18	Oregon	The Cascade Range Forest Reserve	4,492,800	Sept. 28, 1893	4,492,800	
19	19	do	Ashland Forest Reserve	18,560	do	18,560	
20	20	California	The Stanislaus Forest Reserve	691,200	Feb. 22, 1897	691,200	
21	21	do	The San Jacinto Forest Reserve	737,280	do	737,280	
22	22	Idaho and Montana	The Bitter Root Forest Reserve	4,147,200	do	4,147,200	
23	23	Idaho and Washington.	The Priest River Forest Reserve	645,120	do	645,120	
24, 39	24	South Dakota	The Black Hills Forest Reserve		do	967,680	See proclamation No. 39.
25	25	Utah	The Uintah Forest Reserve	875,520	do	875,520	
26	26	Washington	The Washington Forest Reserve	3,594,240	do	3,594,240	
27	27	do	The Olympic Forest Reserve	2,188,800	do	2,188,800	

[1] See figure 4, page 296, for map showing locations of these reserves. The first number in each line of the first column of this table is the number of the reserve and refers to the principal proclamation; the succeeding numbers refer to subsidiary proclamation.

Forest reserves of the United States, names, locations, areas, etc.—Continued.

Numbers of— Reserves.	Numbers of— Proclamations.	States.	Names of reserves.	Present areas of reserves.	Dates of proclamations.	Areas of reserves.	Remarks.
			ADMINISTRATION OF PRESIDENT HARRISON—Continued.	*Acres.*		*Acres.*	
28, 14, 44	28	Washington	The Mount Rainier Forest Reserve		Feb. 22, 1897	1,267,200	The original reserve comprised 2,234,880 acres, including "The Pacific Forest Reserve." This area was reduced March 2, 1899, to 2,027,520 acres. See proclamation No. 44.
29	29	Wyoming	The Big Horn Forest Reserve	1,127,680	do	1,127,680	
30	30	do	The Teton Forest Reserve	829,440	do	829,440	
31	31	Montana	The Flathead Forest Reserve	1,382,400	do	1,382,400	
32	32	do	The Lewis and Clarke Forest Reserve	2,926,080	do	2,926,080	
33, 36	33	California	The Pine Mountain and Zaca Lake Forest Reserve.		Mar. 2, 1898	1,144,594	See proclamation No. 36.
						27,035,794	
			ADMINISTRATION OF PRESIDENT M'KINLEY.				
34, 47	34	Arizona	The Prescott Forest Reserve		May 10, 1898	10,240	See proclamation No. 47.
4, 35	35	New Mexico	The Pecos River Forest Reserve	431,040	May 27, 1898	120,000	See proclamation No. 4.
33, 36	36	California	The Pine Mountain and Zaca Lake Forest Reserve.	1,644,594	June 29, 1898	500,000	See proclamation No. 33.
37	37	do	The San Francisco Mountains Forest Reserves.	975,360	Aug. 17, 1898	975,360	Even-numbered sections only reserved.
38	38	Arizona	The Black Mesa Forest Reserve	1,658,880	do	1,658,880	
24, 39	39	South Dakota and Wyoming.	The Black Hills Forest Reserve	1,211,680	Sept. 19, 1898	244,000	See proclamation No. 24.
17, 40	40	California	The Trabuco Canyon Forest Reserve	109,920	Jan. 30, 1899	60,000	See proclamation No. 17.
41	41	Utah	The Fish Lake Forest Reserve	67,840	Feb. 10, 1899	67,840	
42	42	Montana	The Gallatin Forest Reserves	40,320	do	40,320	Even-numbered sections only reserved.
43	43	New Mexico	The Gila River Forest Reserve	2,327,040	Mar. 2, 1899	2,327,040	
28, 14, 44	44	Washington	The Mount Rainier Forest Reserve	2,027,520	do	207,360	The area of "The Mount Rainier National Park" of 207,360 acres which was set aside has been deducted. See proclamation No. 28.
45	45	California	The Lake Tahoe Forest Reserve	136,335	April 13, 1899	136,335	
46	46	do	The Santa Ynez Forest Reserve	145,000	Oct. 2, 1899	145,000	
34, 47	47	Arizona	The Prescott Forest Reserve	423,680	Oct. 21, 1899	413,440	See proclamation No. 34.
						6,491,095	
			Grand total			46,983,969	

AGRICULTURAL LIBRARIES OF THE UNITED STATES.[1]

State.	Post office.	Institution.	Volumes agricultural.	Total volumes.
Alabama	Auburn	State Ag'l and Mechanical College	2,494	12,982
	Uniontown	Canebrake Experiment Station	1,000	
Arizona	Tucson	University of Arizona	248	4,000
Arkansas	Fayetteville	University of Arkansas	750	2,000
California	Berkeley	University of California	3,000	79,000
Colorado	Fort Collins	State Agricultural College	500	9,968
Connecticut	Storrs	Connecticut Agricultural College	1,000	7,000
	New Haven	Conn. Ag'l Experiment Station	2,000	
Delaware	Newark	Delaware College	4,500	10,000
Florida	Lake City	Florida Agricultural College	3,300	5,500
Georgia	Athens	State College of Agriculture and Mechanic Arts.	600	20,000
	College	Georgia State Industrial College	(a)	500
	Dahlonega	North Georgia Agricultural College.	(a)	5,000
	Experiment	Experiment Station	800	800
	Milledgeville	Middle Georgia College	(a)	1,500
Idaho	Moscow	University of Idaho		13,000
Illinois	Urbana	University of Illinois	7,500	45,000
	Glenwood	Illinois School of Agriculture and Manual Training for Boys.	(a)	3,000
Indiana	Lafayette	Purdue University	2,800	9,200
Iowa	Ames	State College of Agriculture and Mechanic Arts.	2,400	13,000
	Des Moines	Iowa Horticultural Society	1,500	1,500
Kansas	Manhattan	Kansas Agricultural College	7,260	19,704
	Topeka	State Board of Agriculture	(a)	1,000
	Topeka	Kansas Horticultural Society	(a)	500
Kentucky	Lexington	Agricultural and Mechanical College of Kentucky.	500	7,015
	Frankfort	State Normal School	957	1,372
Louisiana	New Orleans	Louisiana University	550	1,665
Maine	Orono	University of Maine	2,500	16,000
	Augusta	Maine Board of Agriculture	1,300	1,500
Maryland	College Park	Maryland Agricultural College	(a)	4,000
	College Park	Maryland Horticultural Society	(a)	3,000
Massachusetts	Amherst	Massachusetts Agricultural College.	9,192	19,980
	Jamaica Plain (Boston).	Bussey Institution	(a)	14,569
	Boston, 101 Tremont street.	Massachusetts Horticultural Society.	10,000	10,000
	Boston, State House	Massachusetts Board of Agriculture.	3,200	3,200
	Worcester	Worcester County Horticultural Society.	3,000	3,000
	Winchester	Massachusetts Forestry Association.	500	500
Michigan	Agricultural College	State Agricultural College	9,000	19,380
Minnesota	Minneapolis	University of Minnesota	7,000	50,000
	Minneapolis	Minnesota Horticultural Society	1,800	1,800
	Taylors Falls	Minnesota Forestry Association	100	100
Mississippi	Agricultural College	Mississippi Agricultural and Mechanical College.	3,810	10,084
	Westside	Alcorn Agricultural and Mechanical College.	75	4,000
Missouri	Columbia	University of Missouri	3,000	30,000
Montana	Bozeman	Montana College of Agriculture and Mechanic Arts.	100	4,000
	Bozeman	State Board of Horticulture	300	300
Nebraska	Lincoln	University of Nebraska	4,856	44,000
Nevada	Reno	Nevada State University	(a)	4,000
New Hampshire	Durham	New Hampshire College of Agriculture and Mechanic Arts.	2,100	7,000
New Jersey	New Brunswick	Rutgers College	12,855	40,000
	New Brunswick	Experiment Station	2,885	2,885
	Trenton	State Board of Agriculture	350	400
New Mexico	Mesilla Park	New Mexico College of Agriculture and Mechanic Arts.	500	3,552
New York	Geneva	Experiment Station	4,400	4,400
	Ithaca	Cornell University	15,000	225,000
North Carolina	Raleigh	North Carolina College of Agriculture and Mechanic Arts.	(a)	4,000
North Dakota	Fargo	N. Dakota Agricultural College	3,800	8,000
Ohio	Columbus	Ohio State University	5,000	32,000
	Columbus	State Board of Agriculture	4,000	4,000
	Wooster	Agricultural Experiment Station	1,600	
Oklahoma	Stillwater	Oklahoma Agricultural and Mechanical College.	(a)	3,497
Oregon	Corvallis	Oregon Agricultural College	170	5,000
Pennsylvania	Harrisburg	Pennsylvania State Agricultural Society.	3,125	3,125

[1] The numbers in some cases include pamphlets as well as bound volumes. *a* Not stated.

AGRICULTURAL LIBRARIES OF THE UNITED STATES—Continued.

State.	Post office.	Institution.	Volumes, agricultural.	Total volumes.
Pennsylvania	Philadelphia, Broad above Spruce.	Pennsylvania Horticultural Society.	3,500	3,500
	State College	The Pennsylvania State College	1,311	15,754
	State College	Experiment Station	500	500
Rhode Island	Kingston	Rhode Island College of Agriculture and Mechanic Arts.	2,100	7,800
South Carolina	Clemson College	Clemson College	(a)	5,000
	Georgetown	Winyah Indigo Society	(a)	2,000
South Dakota	Brookings	South Dakota Agricultural College.	585	4,974
Tennessee	Knoxville	University of Tennessee	8,000	20,000
Texas	College Station	State Agricultural and Mechanical College.	450	6,000
Utah	Logan	Agricultural College of Utah	364	7,201
Vermont	Burlington	University of Vermont	(a)	57,384
Virginia	Blacksburg	Virginia Polytechnic Institute	(b)	----------
	Hampton	Hampton Agricultural Institute	600	9,600
Washington	Pullman	Washington Agricultural College and School of Science.	(a)	5,132
West Virginia	Morgantown	West Virginia University	3,176	17,500
Wisconsin	Madison	University of Wisconsin	5,000	50,000
Wyoming	Laramie	University of Wyoming	1,366	7,000

a Not stated. *b* Library recently burned.

BOARDS OF TRADE THAT PUBLISH COMMERCIAL NEWS.

City and State.	Name of organization.	Secretary.
Baltimore, Md	Chamber of Commerce	W. F. Wheatley.
Boston, Mass	do	Elwyn G. Preston.
Buffalo, N. Y	Merchants' Exchange	C. H. Keep.
Chicago, Ill	Board of Trade	George F. Stone.
Cincinnati, Ohio	Chamber of Commerce	Charles B. Murray (Sup't).
Denver, Colo	Chamber of Commerce and Board of Trade.	Arthur Williams.
Detroit, Mich	Board of Trade	F. W. Waring.
Duluth, Minn	do	S. A. Kemp.
Indianapolis, Ind	do	Jacob W. Smith.
Louisville, Ky	do	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.
Peoria, Ill	do	R. C. Grier.
Philadelphia, Pa	Commercial Exchange	Armon D. Acheson.
Do	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.
Do	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	V. V. Bullock.
Augusta, Ga	Exchange and Board of Trade	W. F. Alexander.
Birmingham, Ala	Commercial Club	J. B. Gibson.
Charleston, S. C	Cotton Exchange	R. A. Tavel.
Columbia, S. C	Board of Trade	W. E. McNulty.
Columbus, Ga	do	Rhodes Brown.
Dallas, Tex	Commercial Club	Paul Giraud.
Eufaula, Ala	Cotton Exchange	H. Lampley.
Fort Worth, Tex	Chamber of Commerce	S. M. Smith.
Galveston, Tex	Cotton Exchange and Board of Trade	S. O. Young.
Greenville, Miss	Cotton Exchange	Edward Holland.
Greenwood, Miss	do	C. K. Marshall.
Houston, Tex	Cotton Exchange and Board of Trade	B. R. Warner.
Little Rock, Ark	Board of Trade	George R. Brown.

COTTON EXCHANGES—Continued.

City and State.	Name of organization.	Secretary.
Memphis, Tenn	Cotton Exchange	Henry Hotter.
Meridian, Miss	Board of Trade and Cotton Exchange	P. E. Walker.
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	do	Robert P. McDougall.
Norfolk and Portsmouth, Va.	do	S. B. Harrell (Treas.).
Raleigh, N. C	Cotton and Grocers' Exchange	P. T. Wyatt.
Richmond, Va	Grain and Cotton Exchange	B. A. Jacob.
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	do	C. A. McKinnon.
Sherman, Tex	Commercial Club	M. L. Kelly.
Shreveport, La	Board of Trade	Henry Hawkins.
Texarkana, Ark	do	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 AND FARM ANIMALS.

[From Division of Statistics.]

Acreage, production, value, prices, and exports of corn in the United States, 1866 to 1899, 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 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	34	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	29.4	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	32⅝	36⅛	99,572,329
1880	62,317,842	27.6	1,717,434,543	39.6	679,714,499	35⅝	42	41⅛	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	34⅛	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	33⅛	35⅞	33⅛	35⅝	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	39⅝	59	40⅞	a100	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	22¼	23¾	23	25½	178,817,417
1897	80,095,051	23.8	1,902,967,933	26.3	501,072,952	25	27½	32⅝	37	212,055,543
1898	77,721,781	24.8	1,924,184,660	28.7	552,023,428	33⅛	38	32⅛	34⅝	177,255,046
1899	82,108,587	25.3	2,078,143,933	30.3	629,210,110	30	31½	------	------	------ ------

a Result of corner.

Acreage, production, value, prices, and exports of wheat in the United States, 1866 to 1899, 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 flour, fiscal years beginning July 1.
	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	281,264,700	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	10.4	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	88.2	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	69⅛	76⅜	85⅜	90¾	132,570,366
1885	34,189,246	10.4	357,112,000	77.1	275,320,390	82⅞	89	72⅛	79	94,565,793
1886	36,806,184	12.4	457,218,000	68.7	314,226,020	75⅛	79½	80¾	88¾	153,804,969
1887	37,641,783	12.1	456,329,000	68.1	310,612,960	75⅛	79¼	81¼	89⅞	119,624,344
1888	37,336,138	11.1	415,868,000	92.6	385,248,030	96⅝	105½	77¼	95½	88,600,742
1889	38,123,859	12.9	490,560,000	69.8	342,491,707	76¾	80½	89¾	100	109,430,467
1890	36,087,154	11.1	399,262,000	83.8	334,773,678	87½	92¾	98⅞	108	106,181,316
1891	39,916,897	15.3	611,780,000	83.9	513,472,711	89⅝	93¼	80	85¾	225,665,812
1892	38,554,430	13.4	515,949,000	62.4	322,111,881	69½	73	68¼	76¼	191,912,635
1893	34,629,418	11.4	396,131,725	53.8	213,171,381	59⅛	64½	52⅛	60½	164,283,129
1894	34,882,436	13.2	460,267,416	49.1	225,902,025	52¾	63⅝	60¾	85⅝	144,812,718
1895	34,047,332	13.7	467,102,947	50.9	237,938,998	53¾	64¾	57⅛	67⅝	126,443,968
1896	34,618,646	12.4	427,684,346	72.6	310,602,539	74⅝	93⅛	68¾	97⅞	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	62¾	70	68⅜	79½	222,694,920
1899	44,592,516	12.3	547,303,846	58.4	319,545,259	64	69½	-----	-----	----- -----

Acreage, production, value, prices, exports, and imports of oats in the United States, 1866 to 1899, 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.	Imports during fiscal years beginning July 1.[a]
	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	57½	64½	504,770	1,500,040
1875	11,915,075	29.7	354,317,500	32.0	113,441,491	29½	30½	28⅜	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	28.5	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	20⅝	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	56⅝	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	33.0	187,040,264	29⅜	36⅛	30¾	34¼	3,274,622	121,064
1884	21,300,917	27.4	583,628,000	28.0	161,528,470	22½	25¼	34½	37	6,193,104	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

[a] In years 1866, and 1884 to 1899, inclusive, oatmeal is included.

Acreage, production, value, prices, exports, and imports of oats in the United States, 1866 to 1899, inclusive—Continued.

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.	Imports during fiscal years beginning July 1.
	Acres.	*Bush.*	*Bushels.*	*Cts.*	*Dollars.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Bushels.*	*Bushels.*
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	30½	32½	38	573,080	123,817
1888	26,998,282	30.0	701,735,000	27.8	195,424,240	25	26½	21⅜	23⅝	1,191,471	131,501
1889	27,462,316	27.4	751,515,000	23.0	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	43½	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	25⅞	31¼	28¾	32¼	2,700,793	49,433
1893	27,273,033	23.4	638,854,850	29.4	187,576,092	27¼	29½	32½	36	6,290,229	31,759
1894	27,023,553	24.5	662,036,928	32.4	214,816,920	28¾	29⅝	27½	30¾	1,708,824	330,317
1895	27,878,406	29.6	824,443,537	19.9	163,655,068	16⅝	17¼	18	19⅜	15,156,618	66,602
1896	27,565,985	25.7	707,346,404	18.7	132,485,033	16½	18¼	16¼	18¾	37,725,083	893,908
1897	25,730,375	27.2	698,767,809	21.2	147,974,719	21	23½	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	33,534,264	28,098
1899	26,341,380	30.2	796,177,713	24.9	198,167,975	22¼	23	......	......	....	....

Acreage, production, value, prices, exports, and imports of barley in the United States, 1866 to 1899, 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 fiscal years beginning July 1.	Imports during fiscal years beginning July 1.
	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	1,177,735	22.7	26,718,500	75.8	20,264,015	55	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	63¼	68¼	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	62.8	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	52.2	29,464,390	80	80	69	77	550,884	10,831,461
1888	2,996,382	21.3	63,884,000	59.6	37,672,032	......	......	......	......	1,440,321	11,368,414
1889	3,220,834	24.3	78,332,976	42.7	32,614,271	58	58	......	......	1,408,311	11,332,545
1890	3,135,302	21.0	67,168,344	64.8	42,140,502	......	......	......	......	973,062	5,078,733
1891	3,352,579	25.8	86,839,153	54.0	45,470,342	......	......	......	......	2,800,075	3,146,328
1892	3,400,361	23.7	80,096,762	47.2	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	......	......	7,680,331	837,384
1896	2,950,539	23.6	69,695,223	32.3	22,491,241	......	......	......	......	20,030,301	1,271,787
1897	2,719,116	24.5	66,685,127	37.7	25,142,139	......	......	......	......	11,237,077	124,804
1898	2,583,125	21.6	55,792,257	41.3	23,064,359	......	......	......	......	2,267,400	110,475
1899	2,878,229	25.5	73,381,563	40.3	29,594,254	......	......	......	......	....	....

Acreage, production, value, prices, and exports of rye in the United States, 1866 to 1899, 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 rye flour, fiscal years beginning July 1.
	Acres.	*Bush.*	*Bushels.*	*Cents.*	*Dollars.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Bushels.*
1866	1,548,033	12.8	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	832,639
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	1,003,615
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	58.0	16,300,503	56½	60	60½	62½	6,247,590
1884	2,343,963	12.2	28,640,000	52.0	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	53.1	13,181,330	53	54½	54½	56½	377,302
1887	2,053,447	10.1	20,693,000	54.4	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	309,268
1889	2,171,493	13.1	28,420,299	45.7	12,009,752	44	45½	49½	54	2,280,975
1890	2,141,853	11.8	25,807,472	62.9	16,229,992	64½	68½	83	92	358,263
1891	2,176,466	14.4	31,751,868	77.4	24,589,217	86	92	70½	79	12,068,628
1892	2,163,657	12.7	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	8,581,667
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	10,169,832
1899	1,659,308	14.4	23,961,741	51.0	12,214,118	49	52	------	------	------ ------

Acreage, production, value, and prices of buckwheat in the United States, 1866 to 1899, 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	17.2	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	15.6	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	17.7	14,617,535	59.4	8,682,488
1881	828,815	11.4	9,486,200	86.5	8,205,705
1882	847,112	13.1	11,019,353	72.9	8,038,862
1883	857,349	8.9	7,668,954	82.2	6,303,980
1884	879,403	12.6	11,116,000	59.0	6.549,020
1885	914,394	13.8	12,626,000	55.9	7,057,363
1886	917,915	12.9	11,869,000	54.4	6,465,120
1887	910,506	11.9	10,844,000	56.1	6,122,320
1888	912,630	13.2	12,050,000	63.6	7,627,647
1889	837,162	14.5	12,110,329	51.8	6,113,119
1890	844,579	14.5	12,432,831	57.4	7,132,872

Acreage, production, value, etc., of buckwheat in the United States, 1866 to 1899, inclusive—Continued.

Year.	Acreage.	Average yield per acre.	Production.	Average farm price per bushel, Dec. 1.	Farm value, Dec. 1.
	Acres.	*Bushels.*	*Bushels.*	*Cents.*	*Dollars.*
1891	849,364	15.3	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	12,122,311	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

Acreage, production, value, prices, exports, and imports of potatoes in the United States, 1866 to 1899, inclusive.

Year.	Acreage.	Average yield per acre	Production.	Average farm price per bushel, Dec. 1	Farm value, Dec. 1.	Chicago price per bushel, Burbank. December. Low.	December. High.	May of following year. Low.	May of following year. High.	Domestic exports, fiscal years beginning July 1.	Imports during fiscal years beginning July 1.
	Acres.	*Bush.*	*Bushels.*	*Cts.*	*Dollars.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Bushels.*	*Bushels.*
1866	1,069,381	99.2	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	------	------	------	------	----------	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	1,220,913	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	2,170,572
1881	2,041,670	53.5	109,145,494	90.9	99,291,341	------	------	------	------	408,286	8,789,860
1882	2,171,635	78.7	170,972,508	55.7	95,304,844	------	------	------	------	439,443	2,362,762
1883	2,289,275	90.9	208,164,425	42.2	87,849,991	------	------	------	------	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	68.5	91,506,740	70	83	65	85	403,880	8,259,538
1888	2,533,280	79.9	202,365,000	40.4	81,413,589	30	37	24	45	471,955	883,380
1889	2,647,989	77.4	204,990,345	40.3	72,704,413	33	45	30	60	406,618	3,415,578
1890	2,651,579	57.5	148,078,945	75.8	112,205,235	82	93	95	110	341,189	5,401,912
1891	2,714,770	93.9	254,426,971	35.8	91,024,521	30	40	30	50	557,022	186,871
1892	2,547,962	62.0	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	------	------	581,833	530,420
1899	2,581,353	88.6	228,783,232	39.0	89,328,832	------	------	------	------	----------	----------

Acreage, production, value, prices, and exports of hay in the United States, 1866 to 1899, 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	1.14	25,085,100	12.53	314,241,037					4,889
1874	21,769,772	1.11	25,133,900	11.94	300,222,454					7,183
1875	23,507,964	1.18	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	1.24	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	13.43	415,131,366	16.00	16.50	15.00	16.50	10,570
1882	32,339,585	1.18	38,138,049	9.70	371,170,326	11.50	12.25	12.00	13.00	13,309
1883	35,515,948	1.32	46,864,009	8.19	384,834,451	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	9.34	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	7.88	470,374,948	9.00	10.00	9.00	14.00	36,274
1890	50,712,513	1.20	60,197,589	7.74	473,569,972	9.00	10.50	12.50	15.50	28,066
1891	51,044,490	1.18	60,817,771	8.39	494,113,616	12.50	15.00	13.50	14.00	35,201
1892	50,853,061	1.18	59,823,735	8.49	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	64,918
1899	41,328,462	1.35	56,655,756	7.27	411,926,187	10.50	11.50			

Acreage, production, value, prices, and exports of cotton in the United States, 1866 to 1898, 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	*a* 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					1,288,655
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			23½	24⅞	1,867,074
1872	8,500,000	.46	3,930,508	16.5	280,552,629	19⅛	20¼	19¼	19⅝	2,400,127
1873	9,350,000	.45	4,170,388	14.1	289,853,486	15⅝	16½	17¾	18⅞	2,717,204
1874	10,982,000	.35	3,832,991	13.0	228,113,080	14⅛	14⅞	16⅛	16⅝	2,520,837
1875	10,803,030	.43	4,632,313	11.1	233,109,945	13 1/16	13 5/16	11 13/16	13⅛	2,982,810
1876	11,677,250	.38	4,474,069	9.9	211,655,041	12 1/16	12½	10 13/16	11⅝	2,890,738
1877	12,600,000	.38	4,773,865	10.5	235,721,194	11¼	11⅛	10⅝	11¼	3,215,067
1878	12,266,800	.41	5,074,155	8.2	193,467,706	8 13/16	9½	11⅞	13¾	3,256,745
1879	12,595,500	.46	5,761,252	10.2	242,140,987	12⅝	13 7/16	11 11/16	11⅞	3,644,122
1880	15,475,300	.43	6,605,750	9.8	280,266,242	11⅞	12	10 7/16	10⅞	4,381,857
1881	16,710,730	.33	5,456,048	10.0	294,135,547	11⅞	12⅛	12 1/16	12⅝	3,479,951
1882	16,791,557	.41	6,949,756	9.9	309,696,500	10¼	10 7/16	10½	11⅛	4,576,150
1883	16,777,993	.34	5,713,200	9.0	250,594,750	10⅝	10 9/16	11½	11⅝	3,725,145

a Estimated.

Acreage, production, value, prices, and exports of cotton in the United States, 1866 to 1898, 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.*
1884	17,439,612	.33	5,706,165	9.2	253,993,385	10 7/16	11 7/16	10 11/16	11	3,783,318
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	4,116,074
1886	18,454,603	.35	6,505,087	8.1	309,381,938	9 3/16	9 9/16	10 1/4	11 7/16	4,338,914
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	4,528,241
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 1/4	4,943,599
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	5,870,439
1892	18,067,924	.37	6,700,365	8.4	262,252,286	9 5/8	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 1/4	7 5/8	5,366,564
1894	23,687,950	.42	9,901,251	4.6	287,120,818	5 11/16	5 13/16	6 3/4	7 5/8	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	4,670,452
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	6,207,509
1897	24,319,584	.45	10,897,857	6.6	319,491,412	5 13/32	5 15/16	6 5/16	6 9/16	7,700,528
1898	24,967,295	.45	11,189,205	5.7	305,467,041	5 1/8	5 5/8	6 1/8	6 1/4	7,546,820

Acreage, production, value, and distribution of the principal crops of the United States in 1899, by States.

CORN.

States and Territories.	Crop of 1899. Acreage.	Crop of 1899. Production.	Crop of 1899. Value.	Stock on hand Mar. 1, 1900.		Shipped out of county where grown.
	Acres.	*Bushels.*	*Dollars.*	*Bushels.*	*Per ct.*	*Bushels.*
Maine	11,873	427,428	213,714	98,308	23	0
New Hampshire	25,014	975,546	478,018	243,886	25	0
Vermont	47,526	1,710,936	804,140	564,609	33	0
Massachusetts	40,264	1,449,504	739,247	434,851	30	0
Rhode Island	8,116	251,596	133,346	108,186	43	7,548
Connecticut	46,149	1,799,811	899,906	647,932	36	0
New York	503,389	15,605,059	7,022,277	5,305,720	34	156,051
New Jersey	254,816	9,937,824	3,975,130	4,273,264	43	1,391,295
Pennsylvania	1,257,996	40,255,872	16,504,908	15,699,790	39	3,220,470
Delaware	206,696	4,547,312	1,546,086	2,137,237	47	1,273,247
Maryland	580,076	18,562,432	6,682,476	6,682,476	36	6,125,603
Virginia	1,744,045	34,880,900	13,254,742	12,905,933	37	2,441,663
North Carolina	2,457,936	31,953,168	15,017,989	14,698,457	46	1,597,658
South Carolina	1,857,021	16,715,189	8,356,594	7,520,935	45	334,264
Georgia	3,249,479	32,494,790	16,247,395	15,922,447	49	1,949,687
Florida	509,337	5,093,370	2,699,486	1,935,481	38	203,735
Alabama	2,751,260	33,015,120	15,517,106	15,517,106	47	990,454
Mississippi	2,440,232	39,043,712	17,960,108	19,131,419	49	780,874
Louisiana	1,438,707	25,896,726	11,394,559	10,876,625	42	1,035,869
Texas	4,508,411	81,151,398	29,214,503	29,214,503	36	10,549,682
Arkansas	2,404,357	48,087,140	18,273,113	20,196,599	42	3,366,100
Tennessee	2,999,888	59,997,760	23,399,126	21,599,194	36	5,999,776
West Virginia	693,984	18,043,584	8,119,613	6,134,819	34	1,082,615
Kentucky	2,637,747	55,392,687	20,495,294	18,833,514	34	3,323,561
Ohio	2,751,356	99,048,816	29,714,645	34,667,086	35	19,809,763
Michigan	1,059,054	26,476,350	9,531,486	9,001,959	34	1,588,581
Indiana	3,732,963	141,852,594	38,300,200	52,485,460	37	38,300,200
Illinois	6,865,287	247,150,332	64,259,086	88,974,120	36	79,088,106
Wisconsin	1,191,039	41,686,365	12,505,910	13,756,500	33	2,084,318
Minnesota	944,584	31,171,272	7,481,105	12,156,796	39	4,052,265
Iowa	7,814,511	242,249,841	55,717,463	84,787,444	35	36,337,476
Missouri	6,265,964	162,915,064	48,874,519	55,391,122	34	11,404,054
Kansas	8,800,786	237,621,222	59,405,306	92,672,277	39	54,652,881
Nebraska	8,013,331	224,373,268	51,605,852	85,261,842	38	44,874,654
South Dakota	1,154,516	30,017,416	7,804,528	9,305,399	31	8,404,876
North Dakota	24,065	553,495	182,653	160,514	29	5,535
Montana	1,582	36,386	18,921	3,639	10	0
Wyoming	2,452	53,944	23,196	10,789	20	0

Acreage, production, value, and distribution of the principal crops of the United States in 1899, by States—Continued.

CORN—Continued.

States and Territories.	Crop of 1899.			Stock on hand Mar. 1, 1900.		Shipped out of county where grown.
	Acreage.	Production.	Value.			
	Acres.	*Bushels.*	*Dollars.*	*Bushels.*	*Per ct.*	*Bushels.*
Colorado	171,264	2,911,488	1,251,940	756,987	26	116,460
New Mexico	24,015	480,300	278,574	57,636	12	33,621
Utah	8,134	162,680	95,981	32,536	20	1,627
Washington	5,586	128,478	70,663	37,259	29	0
Oregon	13,519	297,418	190,348	56,509	19	17,845
California	56,925	1,536,975	922,185	430,353	28	76,849
Oklahoma	533,335	10,133,365	2,026,673	3,040,010	30	1,418,671
United States	82,108,587	2,078,143,933	629,210,110	773,729,528	37.2	348,097,934

WHEAT.

	Acres.	*Bushels.*	*Dollars.*	*Bushels.*	*Per ct.*	*Bushels.*
Maine	1,953	43,942	39,987	11,425	26	439
New Hampshire	511	8,789	8,350	1,055	12	0
Vermont	3,560	78,320	66,572	25,062	32	783
Connecticut	300	5,490	5,216	1,702	31	0
New York	378,690	7,005,765	5,604,612	2,522,075	36	1,261,038
New Jersey	123,370	1,788,865	1,341,649	518,771	29	339,884
Pennsylvania	1,505,362	20,472,923	13,512,129	7,165,523	35	5,118,231
Delaware	72,856	932,557	634,139	233,139	25	531,557
Maryland	759,643	10,710,966	7,283,457	2,463,522	23	5,569,702
Virginia	753,625	6,330,450	4,368,010	1,519,308	24	2,215,658
North Carolina	521,731	3,495,598	2,866,390	978,767	28	174,780
South Carolina	148,271	963,762	954,124	154,202	16	0
Georgia	297,239	2,021,225	1,980,800	384,033	19	101,061
Alabama	56,735	431,186	383,756	68,990	16	4,312
Mississippi	3,248	25,010	19,508	6,002	24	0
Texas	814,832	9,044,635	6,150,352	1,356,695	15	2,080,266
Arkansas	227,135	1,953,361	1,250,151	507,874	26	312,538
Tennessee	953,187	8,292,727	6,468,327	1,824,400	22	1,824,400
West Virginia	417,285	3,880,751	2,755,333	1,280,648	33	853,765
Kentucky	901,272	8,201,575	5,413,040	1,804,346	22	1,886,362
Ohio	2,816,761	39,998,006	25,598,724	14,399,282	36	17,599,123
Michigan	1,587,523	13,335,193	8,667,875	4,000,558	30	6,400,893
Indiana	2,587,875	25,361,175	16,231,152	6,086,682	24	11,412,529
Illinois	1,266,541	12,665,410	7,979,208	2,026,466	16	3,546,315
Wisconsin	759,573	11,773,382	7,181,763	4,356,151	37	2,354,676
Minnesota	5,091,312	68,223,581	37,522,969	23,196,018	34	53,896,629
Iowa	1,399,653	18,195,489	10,007,519	5,822,556	32	4,912,782
Missouri	1,151,384	11,398,702	7,037,195	2,507,714	22	2,507,714
Kansas	3,721,229	36,468,044	18,963,383	9,481,691	26	22,974,868
Nebraska	2,018,619	20,791,776	10,187,970	6,653,368	32	10,395,888
South Dakota	3,526,013	37,728,339	18,864,170	10,186,652	27	29,805,388
North Dakota	4,043,643	51,758,630	26,396,901	11,386,899	22	45,547,594
Montana	69,764	1,792,935	1,093,690	573,739	32	645,457
Wyoming	21,029	395,345	264,881	59,302	15	19,767
Colorado	309,611	7,337,781	4,182,535	2,054,579	28	2,935,112
New Mexico	186,946	2,579,855	1,573,712	412,777	16	193,194
Arizona	22,362	342,139	218,969	30,793	9	78,692
Utah	180,505	3,736,454	1,980,321	934,114	25	822,020
Nevada	38,167	687,006	522,125	109,921	16	151,141
Idaho	142,153	3,440,103	1,720,052	1,238,437	36	1,926,458
Washington	956,405	21,710,394	11,072,301	7,815,742	36	16,934,107
Oregon	1,143,205	21,949,536	11,633,254	7,682,338	35	13,608,712
California	2,393,185	33,743,909	20,921,223	12,147,807	36	23,958,175
Oklahoma	1,218,253	16,202,765	8,587,465	2,754,470	17	10,207,742
United States	44,592,516	517,303,846	319,545,259	158,745,595	29.0	305,019,752

OATS.

	Acres.	*Bushels.*	*Dollars.*	*Bushels.*	*Per ct.*	*Bushels.*
Maine	141,619	4,956,665	1,883,533	1,685,266	34	99,133
New Hampshire	29,927	1,047,445	408,504	366,606	35	20,949
Vermont	107,009	3,959,333	1,464,953	1,544,140	39	39,593
Massachusetts	14,819	489,027	185,830	151,598	31	0
Rhode Island	3,668	95,368	35,286	27,657	29	954
Connecticut	18,752	525,056	194,271	152,266	29	10,501
New York	1,464,568	45,401,608	14,982,531	20,430,724	45	3,632,129
New Jersey	95,193	2,284,632	753,929	891,006	39	228,463

Acreage, production, value, and distribution of the principal crops of the United States in 1899, by States—Continued.

OATS—Continued.

States and Territories.	Crop of 1899. Acreage.	Crop of 1899. Production	Crop of 1899. Value.	Stock on hand Mar. 1, 1900.		Shipped out of county where grown.
	Acres.	*Bushels.*	*Dollars.*	*Bushels.*	*Per ct.*	*Bushels.*
Pennsylvania	1,186,304	39,148,032	11,352,929	17,225,134	44	1,565,921
Delaware	16,004	320,080	80,020	105,626	33	25,606
Maryland	72,852	1,675,596	502,679	452,411	27	301,607
Virginia	367,537	5,145,518	1,698,021	1,543,655	30	257,276
North Carolina	398,934	4,787,208	1,962,755	957,442	20	143,616
South Carolina	251,998	3,023,976	1,421,269	241,918	8	30,240
Georgia	476,873	4,291,857	2,060,091	557,941	13	42,919
Florida	35,606	320,454	160,227	41,659	13	9,614
Alabama	301,207	3,012,070	1,295,190	421,690	14	30,121
Mississippi	136,574	1,365,740	682,870	136,574	10	13,657
Louisiana	30,738	553,284	221,314	55,328	10	5,533
Texas	682,719	17,067,975	5,120,392	3,072,236	18	3,413,595
Arkansas	313,918	5,964,442	2,027,910	1,789,333	30	178,933
Tennessee	380,446	5,326,244	1,704,398	1,491,348	28	106,525
West Virginia	137,324	3,158,452	1,105,458	979,120	31	126,338
Kentucky	455,267	8,194,806	2,622,338	2,376,494	29	409,740
Ohio	915,166	32,945,976	8,236,494	11,531,092	35	7,907,034
Michigan	899,972	30,599,048	8,567,733	11,627,638	38	7,037,781
Indiana	1,071,914	34,301,248	7,889,287	10,976,399	32	12,691,462
Illinois	3,349,446	127,278,948	28,001,369	44,547,632	35	62,366,685
Wisconsin	1,880,205	67,687,380	15,568,097	27,751,826	41	18,952,466
Minnesota	1,646,513	52,688,416	11,591,452	25,290,440	48	12,645,220
Iowa	3,848,053	126,985,749	24,127,292	38,095,725	30	50,794,300
Missouri	811,974	20,299,350	4,871,844	7,104,772	35	1,826,942
Kansas	1,349,290	39,129,410	8,608,470	15,651,764	40	8,608,470
Nebraska	1,715,804	51,474,120	11,324,306	19,560,166	38	19,560,166
South Dakota	589,703	15,332,278	3,526,424	7,206,171	47	3,219,778
North Dakota	599,589	17,987,670	4,856,671	8,813,958	49	2,158,520
Montana	60,986	2,317,468	903,813	834,288	36	556,192
Wyoming	11,743	442,290	176,916	66,341	15	0
Colorado	90,698	2,448,846	1,028,515	832,608	34	587,723
New Mexico	7,418	178,032	78,334	21,364	12	35,606
Utah	25,654	872,236	348,894	174,447	20	43,612
Idaho	32,352	1,099,968	417,988	483,986	44	384,989
Washington	81,945	3,031,965	1,152,147	1,091,507	36	1,121,827
Oregon	170,622	5,118,660	2,098,651	2,098,651	41	1,637,971
California	59,477	1,843,787	866,580	479,385	26	184,379
United States	26,341,380	796,177,713	198,167,975	290,937,335	36.5	223,014,086

Acreage, production, and value of barley, rye, buckwheat, potatoes, and hay in the United States in 1899.

BARLEY.

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	11,988	29	347,652	59	17.11	205,115
New Hampshire	4,620	25	115,500	65	16.25	75,075
Vermont	17,384	31	538,904	52	16.12	280,230
Massachusetts	1,695	30	50,850	68	20.40	34,578
Rhode Island	315	29	9,135	70	20.30	6,394
New York	168,853	24	4,052,472	50	12.00	2,026,236
Pennsylvania	8,564	21	179,844	49	10.29	88,124
Texas	1,970	18	35,460	66	11.88	23,404
Tennessee	1,779	11	19,569	64	7.04	12,524
Kentucky	1,381	21	29,001	43	9.03	12,470
Ohio	21,550	28	603,400	45	12.60	271,530
Michigan	38,631	24	927,144	48	11.52	445,029
Indiana	6,132	25	153,300	45	11.25	68,985
Illinois	13,638	29	395,502	47	13.63	185,886
Wisconsin	255,685	30	7,670,550	40	12.00	3,068,220
Minnesota	325,765	25	8,144,125	31	7.75	2,524,679
Iowa	461,996	26	12,011,896	31	8.06	3,723,688
Missouri	720	18	12,960	42	7.56	5,443
Kansas	187,245	17	3,183,165	27	4.59	859,455
Nebraska	36,276	26	943,176	30	7.80	282,953

Acreage, production, and value of barley, rye, buckwheat, potatoes, and hay in the United States in 1899—Continued.

BARLEY—Continued.

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.*
South Dakota	104,798	23	2,410,354	29	6.67	699,003
North Dakota	246,223	24	5,909,352	33	7.92	1,950,086
Montana	6,183	35	216,405	51	17.85	110,367
Colorado	12,069	28	337,932	55	15.40	185,863
New Mexico	1,109	32	35,488	61	19.52	21,648
Utah	5,905	33	194,865	52	17.16	101,330
Idaho	11,586	35	405,510	46	16.10	186,535
Washington	40,296	35	1,410,360	44	15.40	620,558
Oregon	28,497	28	797,916	50	14.00	398,958
California	855,376	26	22,239,776	50	13.00	11,119,888
United States	2,878,229	25.5	73,381,563	40.3	10.28	29,594,254

RYE.

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	983	15	14,745	84	12.60	12,386
New Hampshire	924	15	13,860	81	12.15	11,227
Vermont	3,173	17	53,941	62	10.54	33,443
Massachusetts	8,331	16	133,296	79	12.64	105,304
Connecticut	14,248	18	256,464	64	11.52	164,137
New York	227,160	16	3,633,660	56	8.96	2,034,816
New Jersey	66,719	15	1,000,785	55	8.25	550,432
Pennsylvania	262,406	15	3,936,090	51	7.65	2,007,406
Maryland	25,234	14	353,276	57	7.98	201,367
Virginia	36,719	9	330,471	53	4.77	175,150
North Carolina	45,754	7	320,278	75	5.25	240,208
South Carolina	3,825	5	19,125	109	5.45	20,846
Georgia	15,805	6	94,830	112	6.72	106,210
Alabama	1,822	8	14,576	104	8.32	15,159
Texas	3,766	10	37,660	82	8.20	30,881
Arkansas	1,732	11	19,052	74	8.14	14,098
Tennessee	11,892	9	107,028	67	6.03	71,709
West Virginia	13,229	10	132,290	62	6.20	82,020
Kentucky	24,443	10	244,430	70	7.00	171,101
Ohio	39,120	16	625,920	55	8.80	344,256
Michigan	78,358	14	1,097,012	52	7.28	570,446
Indiana	35,741	13	464,633	48	6.24	223,024
Illinois	76,955	15	1,154,325	47	7.05	542,533
Wisconsin	204,875	15	3,073,125	48	7.20	1,475,100
Minnesota	61,804	18	1,112,472	42	7.56	467,238
Iowa	112,770	18	2,029,860	40	7.20	811,944
Missouri	9,803	13	127,439	50	6.50	63,720
Kansas	140,532	11	1,545,852	42	4.62	649,258
Nebraska	62,319	16	997,104	38	6.08	378,900
South Dakota	2,451	15	36,765	37	5.55	13,603
North Dakota	16,315	15	244,725	37	5.55	90,548
Colorado	2,374	14	33,236	48	6.72	15,953
Utah	3,452	17	58,684	48	8.16	28,168
Washington	2,246	16	35,936	60	9.60	21,562
Oregon	5,616	11	61,776	70	7.70	43,243
California	36,472	15	547,080	70	11.70	426,722
United States	1,659,308	14.4	23,961,741	51.0	7.36	12,214,118

BUCKWHEAT.

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	23,754	22	522,588	44	9.68	229,939
New Hampshire	2,827	20	56,540	50	10.00	28,270
Vermont	9,348	23	215,004	52	11.96	111,802
Massachusetts	2,209	20	44,180	70	14.00	30,926
Connecticut	3,807	19	72,333	63	11.97	45,570
New York	241,543	13	3,140,059	59	7.67	1,852,635
New Jersey	10,422	21	218,862	56	11.76	122,563
Pennsylvania	242,280	20	4,845,600	54	10.80	2,616,624
Delaware	273	18	4,914	49	8.82	2,408
Maryland	7,510	13	97,630	56	7.28	54,673
Virginia	4,616	14	64,624	54	7.56	34,897
North Carolina	1,685	17	28,645	49	8.33	14,036
Tennessee	1,005	12	12,060	57	6.84	6,874

Acreage, production, and value of barley, rye, buckwheat, potatoes, and hay in the United States in 1899—Continued.

BUCKWHEAT—Continued.

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*
West Virginia	14,015	17	238,255	56	9.52	133,423
Ohio	9,415	16	150,640	58	9.28	87,371
Michigan	23,083	11	253,913	55	6.05	139,652
Indiana	5,331	16	85,296	59	9.44	50,325
Illinois	4,762	15	71,430	58	8.70	41,429
Wisconsin	30,936	15	464,040	63	9.45	292,345
Minnesota	11,386	17	193,562	52	8.84	100,652
Iowa	12,098	16	193,568	58	9.28	112,269
Missouri	2,499	14	34,986	61	8.54	21,341
Nebraska	5,104	16	81,664	62	9.92	50,632
Oregon	240	17	4,080	74	12.58	3,019
United States	670,148	16.6	11,094,473	55.7	9.23	6,183,675

POTATOES.

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	46,865	139	6,514,235	42	58.38	2,735,979
New Hampshire	18,662	127	2,370,074	46	58.42	1,090,234
Vermont	24,915	132	3,288,780	36	47.52	1,183,961
Massachusetts	28,065	134	3,760,710	57	76.38	2,143,605
Rhode Island	7,212	142	1,024,104	50	71.00	512,052
Connecticut	25,562	130	3,323,060	46	59.80	1,528,608
New York	326,227	88	28,707,976	40	35.20	11,483,190
New Jersey	47,955	83	3,980,265	51	42.33	2,029,935
Pennsylvania	179,339	85	15,243,815	43	36.55	6,554,840
Delaware	5,239	52	272,428	51	26.52	138,938
Maryland	22,193	64	1,420,352	51	32.64	724,380
Virginia	36,515	66	2,409,990	56	36.96	1,349,594
North Carolina	16,293	57	928,701	66	37.62	612,943
South Carolina	4,141	56	231,896	104	58.24	241,172
Georgia	5,594	46	257,324	83	38.18	213,579
Florida	1,704	69	117,576	124	85.56	145,794
Alabama	5,997	56	335,832	87	48.72	292,174
Mississippi	5,312	61	324,032	102	62.22	330,513
Louisiana	7,947	60	476,820	81	48.60	386,224
Texas	14,499	64	927,936	91	58.24	844,422
Arkansas	28,146	63	1,773,198	71	44.73	1,258,971
Tennessee	25,896	44	1,135,464	65	28.60	738,052
West Virginia	37,122	72	2,672,784	52	37.44	1,389,848
Kentucky	39,710	51	2,025,210	61	31.11	1,235,378
Ohio	162,043	71	11,505,053	43	30.53	4,947,173
Michigan	173,185	66	11,430,210	32	21.12	3,657,667
Indiana	108,082	76	8,214,232	43	32.68	3,532,120
Illinois	163,002	96	15,648,192	41	39.36	6,415,759
Wisconsin	156,337	103	16,102,711	26	26.78	4,186,705
Minnesota	113,423	96	10,888,608	25	24.00	2,722,152
Iowa	198,478	100	19,847,800	23	23.00	4,564,994
Missouri	105,512	83	8,757,496	40	33.20	3,502,998
Kansas	99,646	95	9,466,370	45	42.75	4,259,866
Nebraska	143,560	94	13,494,640	25	23.50	3,373,660
South Dakota	56,925	78	4,440,150	27	21.06	1,198,840
North Dakota	29,854	103	3,074,962	27	27.81	830,240
Montana	4,597	141	648,177	53	74.73	343,534
Wyoming	3,770	125	471,250	61	76.25	287,462
Colorado	32,304	84	2,713,536	55	46.20	1,492,445
New Mexico	734	49	35,966	68	33.32	24,457
Utah	5,446	120	653,520	55	66.00	359,436
Nevada	1,771	102	180,642	90	91.80	162,578
Idaho	4,790	124	593,960	61	75.64	362,316
Washington	15,397	144	2,217,168	50	72.00	1,108,584
Oregon	14,934	115	1,717,410	49	56.35	841,531
California	26,543	119	3,158,617	63	74.97	1,989,929
United States	2,581,353	88.6	228,783,232	39.0	34.60	89,328,832

Acreage, production, and value of barley, rye, buckwheat, potatoes, and hay in the United States in 1899—Concluded.

HAY.

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	976,848	0.90	879,163	10.10	9.09	8,879,546
New Hampshire	602,097	.89	535,866	11.75	10.46	6,296,426
Vermont	843,235	1.14	961,288	9.25	10.55	8,891,914
Massachusetts	590,707	1.13	667,499	15.50	17.52	10,346,234
Rhode Island	73,008	.89	64,977	17.25	15.35	1,120,853
Connecticut	475,482	.94	446,953	14.50	13.63	6,480,818
New York	4,356,064	1.04	4,530,307	10.45	10.87	47,341,708
New Jersey	392,191	.83	325,519	15.35	12.74	4,996,717
Pennsylvania	2,557,475	1.20	3,068,970	11.50	13.80	35,293,155
Delaware	46,750	1.04	48,620	11.65	12.12	566,423
Maryland	282,992	1.13	319,781	12.15	13.73	3,885,339
Virginia	534,603	1.10	588,063	10.25	11.27	6,027,646
North Carolina	130,526	1.50	195,789	10.10	15.15	1,977,469
South Carolina	144,354	1.22	176,112	10.30	12.56	1,813,954
Georgia	109,287	1.45	158,466	13.15	19.07	2,083,828
Florida	5,942	1.46	8,675	15.35	22.41	133,161
Alabama	49,847	1.66	82,746	11.40	18.92	943,304
Mississippi	54,902	1.44	79,059	9.25	13.32	731,296
Louisiana	25,405	1.95	49,540	9.70	18.92	480,538
Texas	311,156	1.43	444,953	7.10	10.15	3,159,166
Arkansas	138,845	1.48	205,491	8.65	12.80	1,777,497
Tennessee	243,348	1.31	318,786	11.25	14.74	3,586,342
West Virginia	498,998	1.29	643,707	9.45	12.19	6,083,031
Kentucky	306,173	1.29	394,963	10.40	13.42	4,107,615
Ohio	1,641,307	1.30	2,133,699	8.95	11.63	19,096,606
Michigan	1,352,766	1.22	1,650,375	8.50	10.37	14,028,188
Indiana	1,562,221	1.34	2,093,376	7.80	10.45	16,328,333
Illinois	1,833,884	1.29	2,365,710	7.75	10.00	18,334,252
Wisconsin	1,324,298	1.47	1,946,718	6.85	10.07	13,335,018
Minnesota	1,514,841	1.70	2,575,230	4.35	7.40	11,202,250
Iowa	3,750,727	1.34	5,025,974	5.30	7.10	26,637,662
Missouri	2,258,682	1.37	3,094,394	6.25	8.56	19,339,962
Kansas	3,284,018	1.57	5,155,908	3.50	5.49	18,045,678
Nebraska	2,034,758	1.66	3,377,698	3.70	6.14	12,497,483
South Dakota	1,943,688	1.43	2,779,474	3.10	4.43	8,616,369
North Dakota	384,048	1.58	606,796	3.30	5.21	2,002,427
Montana	361,923	1.42	513,931	7.70	10.93	3,957,269
Wyoming	271,961	1.47	399,783	6.60	9.70	2,638,568
Colorado	776,321	2.10	1,630,274	7.35	15.43	11,982,514
New Mexico	38,310	1.70	65,127	10.60	18.02	690,346
Arizona	27,624	2.63	72,651	10.35	27.22	751,938
Utah	194,341	2.50	485,852	7.10	17.75	3,449,549
Nevada	157,480	1.87	294,488	7.65	14.31	2,252,833
Idaho	215,958	2.50	539,895	6.30	15.75	3,401,338
Washington	303,794	2.02	613,664	8.90	17.98	5,461,610
Oregon	637,190	1.97	1,255,264	6.85	13.49	8,598,558
California	1,708,087	1.63	2,784,182	8.00	13.04	22,273,456
United States	41,328,462	1.35	56,655,756	7.27	9.97	411,926,187

TOBACCO STATISTICS.

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, 1892 to 1898, as compiled from the reports of the Bureau of Internal Revenue and of the Bureau of Statistics of the Treasury Department.

	1892.	1893.	1894.	1895.	1896.	1897.	1898.
Tobacco manufactured:							
Chewing, smoking, and snuff *a*	*Pounds.* 234, 081, 332	*Pounds.* 249, 858, 869	*Pounds.* 250, 994, 675	*Pounds.* 234, 561, 904	*Pounds.* 265, 871, 158	*Pounds.* 247, 358, 414	*Pounds.* *b*286, 453, 738
Cigars and cigarettes *a*	96, 925, 980	89, 973, 814	93, 639, 213	95, 053, 056	96, 213, 473	102, 519, 323	*b*106, 855, 524
Exports, domestic *a*	277, 258, 871	304, 797, 808	293, 637, 217	300, 047, 687	281, 074, 422	269, 966, 833	346, 823, 677
Exports, foreign *a*	1, 611, 863	1, 776, 636	3, 060, 385	2, 767, 454	1, 779, 103	2, 323, 516	1, 847, 637
	609, 878, 046	646, 407, 127	641, 331, 490	632, 430, 101	644, 938, 156	622, 168, 086	741, 980, 576
Less imports *a*	22, 093, 270	24, 899, 175	31, 355, 899	20, 258, 704	12, 848, 743	11, 307, 830	17, 107, 839
	587, 784, 776	621, 507, 952	609, 975, 591	612, 171, 397	632, 089, 413	610, 860, 256	724, 872, 737

a For calendar year following. *b* Preliminary estimates.

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 1892 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.*

CONSUMPTION OF AMERICAN COTTON BY FOREIGN COUNTRIES.

The comparative figures in the following table are compiled from the reports of the Bureau of Statistics of the Treasury Department, and are for fiscal years ended June 30. They show the number of bales of cotton exported to each foreign country in 1889, as compared with the years 1898 and 1899. As the exports contain sea-island as well as some light-weight round bales, all bales are reduced to the uniform weight of 500 pounds each.

Exports of cotton from United States to foreign countries.

[In bales of 500 pounds.]

Countries.	Year ending June 30, 1889.		Year ending June 30, 1898.		Year ending June 30, 1899.	
	Bales.	Value.	Bales.	Value.	Bales.	Value.
Austria-Hungary	5 610	$275, 275	35, 614	$987, 724	57, 127	$1, 576, 175
Belgium	147, 807	7, 556, 687	161, 942	4, 809, 609	129, 525	3, 599, 471
Denmark			24, 741	732, 810	39, 249	1, 078, 300
France	400, 196	20, 174, 839	842, 038	24, 599, 724	893, 406	21, 946, 691
Germany	660, 756	32, 308, 593	1, 858, 524	54, 886, 245	1, 728, 975	47, 346, 679
Italy	131, 068	6, 460, 413	387, 581	11, 468, 025	417, 353	11, 652, 768
Netherlands	44, 354	2, 188, 771	43, 509	1, 292, 788	51, 621	1, 401, 040
Portugal			18, 835	588, 923	21, 627	612, 132
Russia	144, 036	7, 506, 201	103, 825	3, 133, 758	95, 011	2, 796, 793
Spain	181, 533	9, 200, 998	263, 648	8, 180, 970	248, 635	7, 194, 009
Sweden and Norway	8, 717	420, 412	25, 613	744, 287	23, 624	703, 503
United Kingdom	2, 940, 860	146, 605, 505	3, 532, 101	105, 853, 614	3, 609, 444	99, 709, 352
Other Europe	9, 547	475, 182				
Dominion of Canada	61, 143	2, 980, 556	122, 495	3, 961, 586	98, 230	2, 994, 674
Mexico	33, 803	1, 607, 395	42, 433	1, 321, 473	36, 130	1, 043, 473
West Indies (French)			17	653	5	187
China			11, 302	370, 670	4, 060	131, 734
East Indies (British)			297	9, 130	9	308
Hongkong			1, 800	72, 000	56	1, 710
Japan	47	2, 341	224, 214	7, 428, 226	182, 734	5, 774, 784
All other countries	216	12, 102				
Total	4, 769, 623	237, 775, 270	7, 700, 529	230, 442, 215	7, 546, 821	209, 564, 774

Except in the cases of Belgium and Russia, the increase in exports has been very large, in some cases the amount being more than double what it was eight or ten years ago. The decrease in exports to Russia of 40,211 bales in 1898 as compared with 1889, and of 49,025 in 1899, is additional evidence of the growth of cotton culture in the trans-Caucasian provinces of that Empire, and of the effort to become independent of the United States.

There is a decrease in the consumption of American cotton in 1899 as compared with 1898 in all countries except Austria-Hungary, Denmark, Italy, the Netherlands, Portugal, and the United Kingdom. The most notable reductions are 129,549 bales in Germany, 41,480 in Japan, 38,632 in France, and 32,417 bales in Belgium. On the other hand the countries showing an increase are as follows: United Kingdom 77,343 bales, Italy 29,772, Austria-Hungary 21,513, Denmark 14,508, the Netherlands 8,112, and Portugal 2,792 bales. But notwithstanding a net decrease of 153,708 bales last year, as compared with the year previous, 1898 and 1899 are conspicuous as having recorded the largest exports of cotton in the history of our commerce. The extremely low prices in 1897–98 and 1898–99 reduced the export values \$7,333,055 in the former and \$28,210,496 in the latter year, as compared with those of 1889, although the number of bales exported in 1898 was 2,930,896 and in 1899 was 2,777,188 greater than in 1889.

THE WORLD'S CONSUMPTION OF COTTON.

While there are no available statistics showing the annual crops of all the cotton-producing countries, the consumption of the mills in Great Britain, the continent of Europe, the United States, India, Japan, Canada, Mexico, and other countries fairly approximates the world's production, the unknown quantity being the domestic consumption in China and a few other countries in the Orient that produce comparatively small crops.

The following statistics, taken from Mr. Thomas Ellison's Annual Review of the Cotton Trade, issued in Liverpool, November 1, 1899, show the number of bales of cotton consumed by the mills of the world from 1890–91 to 1898–99, inclusive:

The world's consumption of cotton, 1890–91 to 1898–99.

[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	488,000	11,822,000
1898	3,432,000	4,628,000	2,962,000	1,141,000	713,000	12,876,000
1899	3,519,000	4,836,000	3,553,000	1,297,000	727,000	13,932,000

These figures certainly show a very gratifying increase in the consumption of cotton, the increase in all countries in 1898–99 over the previous year amounting to 1,056,000 bales, of which more than one-half was in the United States, while the increase in all countries since 1890–91 amounts to 3,476,000 bales. But it is especially gratifying when the increase in the United States is compared with that of other countries. In 1898–99 this increase, as compared with the previous year, amounts to 591,000 bales, as against 208,000 in all continental European countries, 156,000 in India, and 87,000 in Great Britain. Since 1890–91 the United States shows an increase of 1,186,000 bales, as compared with 1,205,000, in all continental European countries, 373,000 in India, and 135,000 in Great Britain.

Cotton crop of 1898–99.

[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	1,079,871	121,128	1,200,999	22,986	1,971	24,957	1,176,042
Arkansas	940,773	3,288	944,061	24,592	....	24,592	919,469
Florida	35,064	....	35,064	....	....	....	35,064
Georgia	1,232,810	281,527	1,514,337	135,589	17	135,606	1,378,731
Indian Territory	215,269	....	215,269	7,431	....	7,431	207,838
Kansas	3	....	3	....	....	....	3
Kentucky	50	25,447	25,497	25,447	....	25,447	50
Louisiana	879,264	18,749	898,013	160,414	19,852	180,266	717,747
Mississippi	1,302,420	21,650	1,324,070	76,942	....	76,942	1,247,128
Missouri	33,120	3,017	36,137	3,017	....	3,017	33,120
North Carolina	336,407	374,891	711,298	79,113	2,565	81,678	629,620
Oklahoma	109,479	....	109,479	453	....	453	109,026
South Carolina	581,788	466,181	1,047,969	10,953	1,602	12,555	1,035,414
Tennessee	311,321	36,358	347,679	24,859	....	24,859	322,820
Texas	3,413,245	17,156	3,430,401	60,493	6,799	67,292	3,363,109
Utah	....	34	34	....	....	....	34
Virginia	13,990	44,502	58,492	44,502	....	44,502	13,990
Total	10,484,874	1,413,928	11,898,802	676,791	32,806	709,597	11,189,205

Comparative acreage and production, 1897 and 1898.

[In commercial bales.]

States and Territories.	Acres.		Bales.		Acres.		Bales.	
	1897.	1898.	1897–98.	1898–99.	Increase.	Decrease.	Increase.	Decrease.
Alabama	2,709,460	3,003,176	1,112,681	1,176,042	293,716	....	63,361	....
Arkansas	1,619,785	1,876,467	942,267	919,469	256,682	....	....	22,798
Florida	251,109	152,452	53,657	35,064	....	98,657	....	18,593
Georgia	3,537,702	3,535,205	1,350,781	1,378,731	....	2,497	27,950	....
Indian Territory	317,992	314,906	207,386	207,838	....	3,086	452	....
Kansas	285	8	139	3	....	277	....	136
Kentucky	105	137	35	50	32	....	15	....
Louisiana	1,245,399	1,281,691	788,325	717,747	36,292	....	....	70,578
Mississippi	2,778,610	2,900,298	1,524,771	1,247,128	121,688	....	....	277,643
Missouri	83,319	82,318	26,848	33,120	....	1,001	6,272	....
North Carolina	1,302,437	1,311,708	646,726	629,620	9,271	....	....	17,106
Oklahoma	216,664	215,893	110,175	109,026	....	771	....	1,149
South Carolina	2,074,778	2,353,213	1,030,085	1,035,414	278,435	....	5,329	....
Tennessee	967,077	896,722	268,635	322,820	....	70,355	54,185	....
Texas	7,164,175	6,991,904	2,822,408	3,363,109	....	172,271	540,701	....
Utah	75	35	60	34	....	40	....	26
Virginia	50,612	51,162	12,878	13,990	550	....	1,112	....
Total	24,319,584	24,967,295	10,897,857	11,189,205	*a* 647,711	....	*a* 291,348	....

a Net increase.

United States crops, exports, imports, and consumption of cotton, 1888–89 to 1898–99.

Years.	United States crop (commercial bales).	Exports (commercial bales). *a*	Consumed by United States mills (commercial bales).	Average net weight per bale.	Average price (middling upland), New York.	Imports (500-pound bales). *a*
				Pounds.	*Cents.*	
1888-89	6,938,290	4,830,463	2,314,691	470	10.71	15,946
1889-90	7,311,322	5,003,879	2,390,959	471	11.53	17,212
1890-91	8,652,597	5,856,194	2,632,023	473	9.03	41,818
1891-92	9,035,379	5,917,249	2,876,846	473	7.64	57,328
1892-93	6,700,365	4,494,047	2,431,134	475	8.24	86,736
1893-94	7,549,817	5,336,553	2,319,688	474	7.67	55,412
1894-95	9,901,251	6,889,577	2,946,677	484	6.50	98,644
1895-96	*b* 7,161,094	4,751,602	2,504,972	477	8.16	110,701
1896-97	*b* 8,532,075	6,092,537	2,847,351	477	7.72	103,798
1897-98	*b* 10,897,857	7,690,477	3,443,581	482	6.22	105,321
1898-99	*b* 11,189,205	*c* 7,424,913	3,589,494	489	6.00	112,361

a From Bureau of Statistics, Treasury Department.
b Estimates of Department; other figures for production are those of Latham & Co.
c Preliminary estimate.

Condition of crops in the United States, monthly, 1885-1899.

Year.	Winter wheat					Spring wheat.				Corn.			
	April.	May.	June.	July.	When harvested.	June.	July.	August.	When harvested.	July.	August.	September.	October.
1885	76.3	70.0	62.0	65.0	66.0	97.0	96.0	95.0	86.0	94.0	96.0	95.0	95.0
1886	94.1	94.9	92.7	91.2	90.8	98.5	83.3	80.1	83.5	95.2	80.7	76.6	80.0
1887	88.1	85.8	84.9	83.5	84.0	87.3	79.3	78.8	78.1	97.7	80.5	72.3	72.8
1888	82.0	73.1	73.3	75.6	77.4	92.8	95.9	87.3	77.2	93.0	95.5	94.2	92.0
1889	94.0	96.0	93.1	92.0	89.4	94.4	83.3	81.2	83.8	90.3	94.8	90.9	91.7
1890	81.0	80.0	78.1	76.2	73.5	91.3	94.4	83.2	79.8	93.1	73.3	70.1	70.6
1891	96.9	97.9	96.6	96.2	96.7	92.6	94.1	95.5	97.2	92.8	90.8	91.1	92.5
1892	81.2	84.0	88.3	89.6	87.6	92.3	90.9	87.3	81.2	81.1	82.5	79.6	79.8
1893	77.4	75.3	75.5	77.7	*a*74.0	86.4	74.1	67.0	......	93.2	87.0	76.7	75.1
1894	86.7	81.4	83.2	83.9	*a*83.7	88.0	68.4	67.1	......	95.0	69.1	63.4	64.2
1895	81.4	82.9	71.1	65.8	*a*75.4	97.8	102.2	95.9	......	99.3	102.5	96.4	95.5
1896	77.1	82.7	77.9	75.6	*a*74.6	99.9	93.3	78.9	......	92.4	96.0	91.0	90.5
1897	81.4	80.2	78.5	81.2	*a*85.7	89.6	91.2	86.7	......	82.9	84.2	79.3	77.1
1898	86.7	86.5	90.8	85.7	*a*86.7	100.9	95.0	96.5	......	90.5	87.0	84.1	82.0
1899	77.9	76.2	67.3	65.6	*a*70.9	91.4	91.7	83.6	......	86.5	89.9	85.2	82.7

Year.	Oats.				Rye.					
	June.	July.	August.	September.	April.	May.	June.	July.	August.	When harvested.
1885	94.0	97.0	96.0	93.0	87.7	86.0	83.0	87.0	94.0	......
1886	95.9	88.8	87.4	90.9	96.6	95.7	94.4	95.6	88.6	93.4
1887	91.0	85.9	85.6	83.4	92.0	90.8	88.9	88.0	84.6	82.2
1888	95.4	95.2	91.7	87.2	93.5	92.9	93.9	95.1	91.4	92.8
1889	93.8	94.1	92.3	90.0	93.9	96.5	95.2	96.7	95.4	91.6
1890	89.8	81.6	70.1	64.4	92.8	93.5	92.3	92.0	86.8	85.4
1891	85.1	87.6	89.5	90.7	95.4	97.2	95.4	93.9	89.6	95.1
1892	88.5	87.2	86.2	78.9	87.0	88.9	91.0	92.9	89.8	88.5
1893	88.9	88.8	78.3	74.9	85.7	82.7	84.6	83.8	78.5	82.0
1894	87.0	77.7	76.5	77.8	94.4	90.7	93.2	93.9	79.8	86.9
1895	84.3	83.2	84.5	86.0	87.0	88.7	85.7	82.2	84.0	83.7
1896	98.8	96.3	77.3	74.0	82.9	87.7	85.2	83.8	88.0	82.0
1897	89.0	87.5	86.0	84.6	88.9	88.0	89.9	95.0	89.8	90.1
1898	98.0	92.8	84.2	79.0	92.1	94.5	97.1	93.8	93.7	89.4
1899	88.7	90.0	90.8	87.2	84.9	85.2	84.5	83.3	89.0	82.0

Year.	Barley.					Buckwheat.			Potatoes.			
	May.	June.	July.	August.	September.	August.	September.	October.	July.	August	September.	October.
1885	82.0	......	92.0	92.0	......	94.0	......	92.0	97.0	95.0	93.0	82.0
1886	96.7	100.0	89.7	90.9	92.7	94.1	89.8	86.5	96.6	88.3	81.4	81.0
1887	87.8	87.0	82.8	86.2	83.0	93.3	89.1	76.6	93.2	80.8	67.3	61.5
1888	88.3	88.8	91.0	89.4	86.9	92.5	93.7	79.1	95.7	93.2	91.6	86.8
1889	96.9	95.6	91.9	90.6	88.9	95.2	92.1	90.0	95.1	94.3	81.7	77.9
1890	84.6	86.4	88.3	82.8	78.6	90.1	90.5	90.7	91.7	77.4	65.7	61.7
1891	96.2	90.3	90.9	93.8	94.3	97.3	96.6	92.7	95.3	96.5	94.8	91.3
1892	92.8	92.1	92.0	91.1	87.4	92.9	89.0	85.6	90.0	86.8	74.8	67.7
1893	88.6	88.3	88.8	84.6	83.8	88.8	77.5	73.5	94.8	86.0	71.8	71.2
1894	62.3	82.2	76.8	69.8	71.5	82.3	69.2	72.0	92.3	74.0	62.4	64.3
1895	94.0	90.3	91.9	87.2	87.6	85.2	87.5	84.8	91.5	89.7	90.8	87.4
1896	89.2	98.0	88.1	82.9	83.1	96.0	93.2	86.0	99.0	94.8	83.2	81.7
1897	96.4	87.4	88.5	87.5	86.4	94.9	95.1	90.8	87.8	77.9	66.7	61.6
1898	......	78.8	85.7	79.3	79.2	87.2	88.8	76.2	95.5	83.9	77.7	72.5
1899	......	91.4	92.0	93.6	86.7	93.2	75.2	70.2	93.8	93.0	86.3	81.7

a Includes winter and spring.

Condition of crops in the United States, monthly, 1885–1899—Continued.

Year.	Hay.				Cotton.				
	Clover.		Timothy.						
	June.	July.	July.	Aug.	June.	July.	August.	September.	October.
1885					92.0	96.0	96.5	87.0	78.0
1886				91.2	88.7	86.1	81.3	82.1	79.3
1887				80.6	96.9	96.9	93.3	82.8	76.5
1888					88.2	86.7	87.3	83.8	78.9
1889				94.5	86.4	87.6	89.3	86.6	81.5
1890	95.1	94.0	93.9	93.6	88.8	91.4	89.5	85.5	80.0
1891	91.0	89.3	87.4	90.9	85.7	88.6	88.9	82.7	75.7
1892	94.9	95.5	96.8	93.2	85.9	86.9	82.3	76.8	73.3
1893	92.7	92.6	89.8	89.6	85.6	82.7	80.4	73.4	70.7
1894	87.8	80.2	77.3	75.6	88.3	89.6	91.8	85.9	82.7
1895	82.8	73.9	70.8	69.9	81.0	82.3	77.9	70.8	65.1
1896	88.4	83.7	84.8	87.5	97.2	92.5	80.1	64.2	60.7
1897	96.0				83.5	86.0	86.9	78.3	70.0
1898				99.3	89.0	91.2	91.2	79.8	75.4
1899				86.7	85.7	87.8	84.0	63.5	62.4

Corn crop of the countries named, 1894–1898.[1]

Countries.	1894.	1895.	1896.	1897.	1898.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
United States	1,212,770,000	2,151,138,000	2,283,175,000	1,902,968,000	1,924,185,000
Ontario	16,788,000	25,692,000	24,830,000	25,441,000	24,181,000
Mexico	77,273,000	71,906,000	76,264,000	121,893,000	100,000,000
Total North America	1,306,831,000	2,248,646,000	2,384,269,000	2,050,302,000	2,048,366,000
Chile	5,000,000	9,000,000	9,000,000	8,000,000	9,932,000
Argentina	16,000,000	72,000,000	80,000,000	40,000,000	56,000,000
Uruguay	5,252,000	5,840,000	5,000,000	4,000,000	4,000,000
Total South America	26,252,000	86,840,000	94,000,000	52,000,000	69,932,000
France	27,419,000	26,163,000	30,426,000	30,401,000	23,496,000
Spain	19,085,000	15,714,000	18,252,000	17,000,000	18,000,000
Portugal	15,000,000	15,000,000	15,000,000	15,500,000	15,500,000
Italy	59,603,000	70,483,000	79,910,000	65,891,000	79,640,000
Austria	13,795,000	18,720,000	17,492,000	14,757,000	16,074,000
Hungary	68,448,000	142,743,000	128,866,000	102,239,000	127,639,000
Croatia-Slavonia	12,092,000	17,454,000	17,617,000	14,162,000	17,500,000
Total Austria-Hungary	94,335,000	178,917,000	163,975,000	131,158,000	161,213,000
Roumania	29,892,000	71,323,000	65,428,000	79,753,000	101,870,000
Bulgaria and E. Roumelia	8,000,000	8,000,000	6,400,000	5,000,000	7,000,000
Servia	17,414,000	17,000,000	16,000,000	16,000,000	17,000,000
Russia	23,275,000	31,693,000	23,773,000	51,966,000	47,918,000
Total Europe	294,023,000	434,293,000	419,164,000	412,669,000	471,637,000
Algeria	322,000	493,000	451,000	450,000	333,000
Egypt	32,000,000	33,600,000	34,000,000	35,000,000	32,000,000
Cape Colony	2,761,000	2,378,000	1,650,000	2,761,000	2,061,000
Total Africa	35,083,000	36,471,000	36,101,000	38,211,000	34,394,000
Australasia	9,118,000	8,500,000	10,201,000	9,412,000	9,780,000

RECAPITULATION BY CONTINENTS.

North America	1,306,831,000	2,248,646,000	2,384,269,000	2,050,302,000	2,048,366,000
South America	26,252,000	86,840,000	94,000,000	52,000,000	69,932,000
Europe	294,023,000	434,293,000	419,164,000	412,669,000	471,637,000
Africa	35,083,000	36,471,000	36,101,000	38,211,000	34,394,000
Australasia	9,118,000	8,500,000	10,201,000	9,412,000	9,780,000
Total	1,671,307,000	2,814,750,000	2,943,735,000	2,562,594,000	2,634,109,000

[1] This and the following tables embody such official figures as are available in regard to wheat, rye, barley, oats, maize, rice, sugar, and flax, together with commercial or other estimates for a number of countries for which official data are not furnished. There are many countries which not only issue no official figures, but for which not even rough estimates, or information upon which to base them, can be had; and these are necessarily omitted from the tables. They are, however, for the most part countries whose production enters to a very limited extent into the world's commerce in the articles named, and the part of the world's production covered by the tables embraces substantially all that is of much commercial importance.

Wheat crop of the world, 1895–1899.

Countries.	1895.	1896.	1897.	1898.	1899.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
United States	467,103,000	427,684,000	530,149,000	675,149,000	547,304,000
Ontario	18,183,000	19,184,000	29,765,000	33,042,000	22,158,000
Manitoba	32,777,000	14,825,000	18,837,000	26,112,000	28,802,000
Rest of Canada	6,500,000	6,800,000	7,500,000	9,000,000	9,000,000
Total Canada	57,460,000	40,809,000	56,102,000	68,154,000	59,960,000
Mexico	10,035,000	22,555,000	9,700,000	15,000,000	15,000,000
Total North America	534,598,000	491,048,000	595,951,000	758,303,000	622,264,000
Chile	15,000,000	12,000,000	10,500,000	14,000,000	13,000,000
Argentina	60,000,000	41,433,000	25,410,000	46,603,000	92,167,000
Uruguay	8,915,000	4,059,000	3,600,000	6,000,000	7,164,000
Total South America	83,915,000	57,492,000	39,510,000	66,603,000	112,331,000
Great Britain	38,348,000	58,851,000	56,672,000	75,330,000	67,594,000
Ireland	1,109,000	1,194,000	1,355,000	1,856,000	1,731,000
Total United Kingdom	39,457,000	60,045,000	58,027,000	77,186,000	69,325,000
Norway	260,000	300,000	300,000	300,000	260,000
Sweden	3,705,000	4,704,000	4,678,000	4,542,000	4,430,000
Denmark	3,467,000	3,689,000	3,474,000	2,991,000	3,500,000
Netherlands	4,282,000	5,045,000	4,280,000	5,000,000	4,300,000
Belgium	12,878,000	13,748,000	11,967,000	14,069,000	12,400,000
France	340,432,000	339,793,000	246,596,000	363,498,000	366,079,000
Spain	81,218,000	71,892,000	94,637,000	99,000,000	88,000,000
Portugal	7,000,000	5,600,000	8,200,000	7,800,000	6,400,000
Italy	118,162,000	145,233,000	86,919,000	137,345,000	137,912,000
Switzerland	5,000,000	4,800,000	4,300,000	4,500,000	4,200,000
Germany	116,545,000	125,661,000	119,903,000	132,557,000	141,369,000
Austria	41,770,000	44,004,000	35,859,000	47,357,000	42,282,000
Hungary	158,012,000	149,954,000	83,590,000	128,140,000	138,060,000
Croatia-Slavonia	8,661,000	9,614,000	6,271,000	11,408,000	9,500,000
Bosnia-Herzegovina	2,000,000	2,050,000	2,000,000	2,100,000	2,000,000
Total Austria-Hungary	210,443,000	205,622,000	127,720,000	189,005,000	191,842,000
Roumania	68,502,000	71,194,000	36,448,000	58,457,000	26,064,000
Bulgaria	37,000,000	48,275,000	30,739,000	35,000,000	24,000,000
Servia	9,400,000	9,300,000	12,500,000	11,000,000	8,560,000
Montenegro	220,000	220,000	200,000	220,000	200,000
Turkey in Europe	21,500,000	24,000,000	17,800,000	25,000,000	15,000,000
Greece	4,000,000	4,800,000	3,200,000	4,000,000	2,000,000
Russia proper	292,272,000	300,423,000	238,557,000	334,246,000	314,876,000
Poland	17,387,000	19,476,000	17,808,000	21,691,000	21,544,000
North Caucasus	67,127,000	45,148,000	29,883,000	52,251,000	57,313,000
Finland	100,000	98,000	90,000	100,000	90,000
Total Russia in Europe	376,886,000	365,145,000	286,338,000	408,288,000	393,823,000
Total Europe	1,460,357,000	1,509,065,000	1,158,236,000	1,579,758,000	1,499,604,000
Siberia	30,899,000	34,160,000	42,835,000	36,157,000	45,473,000
Central Asia	7,462,000	12,830,000	11,087,000	14,944,000	14,938,000
Trans-Caucasia	47,000,000	42,000,000	40,000,000	40,000,000	33,000,000
Total Russia in Asia	85,361,000	88,990,000	93,922,000	91,101,000	93,411,000
Turkey in Asia	46,000,000	44,000,000	48,000,000	44,000,000	35,200,000
Cyprus	2,200,000	2,400,000	2,400,000	2,400,000	2,000,000
Persia	22,000,000	20,000,000	20,000,000	17,600,000	16,000,000
British India	255,244,000	205,743,000	191,257,000	259,670,000	232,585,000
Japan	20,341,000	18,187,000	19,509,000	20,000,000	20,000,000
Total Asia	431,146,000	379,320,000	375,088,000	434,771,000	399,196,000
Algeria	26,793,000	23,631,000	18,000,000	24,118,000	15,000,000
Tunis	7,500,000	5,600,000	5,000,000	6,500,000	4,800,000
Egypt	14,000,000	12,000,000	12,000,000	14,000,000	14,000,000
Cape Colony	2,542,000	2,257,000	2,200,000	2,012,000	2,000,000
Total Africa	50,835,000	43,488,000	37,200,000	46,630,000	35,800,000
West Australia	176,000	194,000	252,000	421,000	892,000
South Australia	8,027,000	6,116,000	2,893,000	4,141,000	9,056,000
Queensland	562,000	128,000	620,000	1,041,000	626,000

Wheat crop of the world, 1895-1899—Continued.

Countries.	1895.	1896.	1897.	1898.	1899.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
New South Wales	7,263,000	5,359,000	9,132,000	10,893,000	9,579,000
Victoria	11,807,000	5,848,000	7,315,000	10,914,000	20,198,000
Tasmania	899,000	1,202,000	1,327,000	1,721,000	2,376,000
New Zealand	3,727,000	7,059,000	6,113,000	5,849,000	13,485,000
Total Australasia	32,461,000	25,906,000	27,652,000	34,980,000	56,212,000

RECAPITULATION BY CONTINENTS.

North America	534,598,000	491,048,000	595,951,000	758,303,000	622,264,000
South America	83,915,000	57,492,000	39,510,000	66,603,000	112,331,000
Europe	1,460,357,000	1,509,066,000	1,158,236,000	1,579,758,000	1,499,604,000
Asia	431,146,000	379,320,000	375,088,000	434,771,000	399,196,000
Africa	50,835,000	43,488,000	37,200,000	46,630,000	35,800,000
Australasia	32,461,000	25,906,000	27,652,000	34,980,000	56,212,000
Total	2,593,312,000	2,506,320,000	2,233,637,000	2,921,045,000	2,725,407,000

Oat crop of the countries named, 1895-1899.

Countries.	1895.	1896.	1897.	1898.	1899.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
United States	824,444,000	707,346,000	698,768,000	730,907,000	796,178,000
Ontario	87,367,000	85,595,000	89,038,000	89,596,000	92,731,000
Manitoba	23,267,000	12,896,000	10,965,000	17,854,000	23,022,000
Rest of Canada	8,500,000	9,000,000	12,000,000	13,000,000	14,000,000
Total Canada	119,134,000	107,491,000	112,003,000	120,450,000	129,753,000
Total North America	943,578,000	814,837,000	810,771,000	851,357,000	925,931,000
Great Britain	125,998,000	117,609,000	120,530,000	122,669,000	118,363,000
Ireland	53,977,000	50,383,000	48,181,000	55,348,000	51,298,000
Total United Kingdom	179,975,000	167,992,000	168,711,000	178,017,000	169,661,000
Sweden	70,242,000	56,090,000	58,473,000	70,416,000	53,698,000
Denmark	40,237,000	38,521,000	35,220,000	41,474,000	37,500,000
Netherlands	15,525,000	15,340,000	16,125,000	17,536,000	16,504,000
Belgium	30,050,000	26,196,000	29,591,000	13,417,000	10,877,000
France	269,235,000	261,078,000	227,595,000	278,277,000	273,305,000
Spain	9,863,000	7,844,000	10,354,000	10,872,000	9,676,000
Italy	19,193,000	22,265,000	19,599,000	18,567,000	16,504,000
Germany	430,209,000	411,263,000	393,983,000	465,321,000	474,179,000
Austria	113,545,000	104,220,000	96,164,000	114,189,000	113,508,000
Hungary	69,137,000	69,930,000	52,644,000	78,708,000	74,976,000
Croatia-Slavonia	4,180,000	4,820,000	4,035,000	7,022,000	4,500,000
Total Austria-Hungary	186,862,000	178,970,000	152,843,000	199,919,000	192,984,000
Roumania	10,375,000	14,720,000	9,852,000	17,410,000	6,255,000
Russia proper	673,978,000	668,973,000	547,323,000	559,920,000	839,639,000
Poland	43,334,000	47,794,000	41,585,000	55,515,000	56,463,000
North Caucasus	14,760,000	12,201,000	6,695,000	12,416,000	12,546,000
Total Russia in Europe	732,072,000	728,968,000	595,603,000	627,851,000	908,648,000
Total Europe	1,993,828,000	1,929,247,000	1,717,949,000	1,939,077,000	2,169,771,000
Siberia	43,826,000	60,733,000	59,550,000	51,258,000	76,853,000
Central Asia	3,558,000	10,131,000	8,559,000	8,423,000	9,804,000
Total Russia in Asia	47,384,000	70,864,000	68,109,000	59,681,000	86,657,000
Total Asia	47,384,000	70,864,000	68,109,000	59,681,000	86,657,000
Algeria	4,402,000	4,486,000	4,126,000	5,088,000	3,095,000
Cape Colony	1,008,000	1,707,000	936,000	1,493,000	1,500,000
Total Africa	5,410,000	6,193,000	5,062,000	6,581,000	4,595,000

Oat crop of the countries named, 1895–1899—Continued.

Countries.	1895.	1896.	1897.	1898.	1899.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
West Australia	21,000	20,000	19,000	30,000	58,000
South Australia	(*a*)	(*a*)	196,000	211,000	314,000
Queensland	31,000	11,000	33,000	32,000	4,000
New South Wales	580,000	386,000	861,000	561,000	287,000
Victoria	5,811,000	2,971,000	7,032,000	4,961,000	5,697,000
Tasmania	957,000	936,000	1,003,000	1,137,000	2,343,000
New Zealand	10,544,000	12,650,000	11,587,000	10,045,000	17,032,000
Total Australasia	17,944,000	16,974,000	20,731,000	16,977,000	25,735,000

RECAPITULATION BY CONTINENTS.

North America	943,578,000	814,837,000	810,771,000	851,357,000	925,931,000
Europe	1,993,838,000	1,929,247,000	1,717,949,000	1,959,077,000	2,169,771,000
Asia	47,384,000	70,864,000	68,109,000	59,681,000	86,657,000
Africa	5,410,000	6,193,000	5,062,000	6,581,000	4,595,000
Australasia	17,944,000	16,974,000	20,731,000	16,977,000	25,735,000
Total	3,008,154,000	2,838,115,000	2,622,622,000	2,873,673,000	3,212,689,000

a No returns.

Barley crop of the countries named, 1895–1899.

Countries.	1895.	1896.	1897.	1898.	1899.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
United States	87,073,000	69,695,000	66,685,000	55,792,000	73,382,000
Ontario	12,471,000	13,069,000	12,401,000	13,063,000	15,298,000
Manitoba	5,823,000	3,272,000	3,284,000	4,413,000	5,549,000
Rest of Canada	2,400,000	2,500,000	2,400,000	2,900,000	2,950,000
Total Canada	20,694,000	18,841,000	18,085,000	20,376,000	23,797,000
Total North America	107,767,000	88,536,000	84,770,000	76,168,000	97,179,000
Great Britain	70,814,000	73,005,000	68,920,000	70,197,000	69,850,000
Ireland	6,579,000	7,272,000	5,982,000	6,889,000	7,061,000
Total United Kingdom	77,393,000	80,277,000	74,902,000	77,086,000	76,911,000
Sweden	14,618,000	14,390,000	14,303,000	14,805,000	11,691,000
Denmark	21,794,000	21,249,000	19,172,000	21,868,000	21,000,000
Netherlands	4,291,000	4,561,000	3,736,000	5,000,000	4,000,000
Belgium	3,900,000	3,987,000	3,457,000	4,000,000	3,700,000
France	48,283,000	46,088,000	41,157,000	46,878,000	47,782,000
Italy	7,435,000	10,057,000	7,700,000	8,900,000	8,000,000
Germany	130,549,000	127,117,000	119,580,000	132,019,000	139,241,000
Austria	59,092,000	54,818,000	49,756,000	60,044,000	58,740,000
Hungary	52,456,000	57,842,000	41,290,000	54,774,000	54,731,000
Croatia-Slavonia	2,413,000	3,021,000	2,143,000	3,373,000	3,201,000
Total Austria-Hungary	113,961,000	115,681,000	93,189,000	118,191,000	116,672,000
Roumania	22,388,000	31,787,000	21,225,000	29,656,000	4,543,000
Bulgaria	16,000,000	20,000,000	11,000,000	13,000,000	10,000,000
Russia proper	210,222,000	208,449,000	203,363,000	254,702,000	179,850,000
Poland	15,912,000	16,744,000	15,967,000	19,480,000	20,090,000
North Caucasus	20,397,000	19,286,000	11,120,000	25,107,000	18,144,000
Total Russia in Europe	246,531,000	244,479,000	230,450,000	299,289,000	218,084,000
Total Europe	707,143,000	719,673,000	639,871,000	770,692,000	661,624,000
Siberia	4,833,000	6,001,000	6,119,000	4,904,000,	5,955,000
Central Asia	1,490,000	3,149,000	2,081,000	2,728,000	2,870,000
Total Russia in Asia	6,323,000	9,150,000	8,200,000	7,632,000	8,825,000
Japan	43,700,000	40,180,000	41,099,000	44,059,000	44,000,000
Total Asia	50,023,000	49,330,000	49,299,000	51,691,000	52,825,000

Barley crop of the countries named, 1895–1899—Continued.

Countries.	1895.	1896.	1897.	1898.	1899.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
Algeria	38,637,000	31,094,000	20,000,000	37,000,000	20,000,000
Tunis	8,000,000	4,000,000	5,000,000	11,000,000	6,000,000
Cape Colony	686,000	690,000	793,000	937,000	900,000
Total Africa	47,323,000	35,784,000	25,793,000	48,937,000	26,900,000
West Australia	15,000	19,000	13,000	24,000	30,000
South Australia	121,000	92,000	111,000	167,000	241,000
Queensland	39,000	8,000	20,000	52,000	36,000
New South Wales	185,000	99,000	114,000	103,000	66,000
Victoria	1,647,000	738,000	841,000	782,000	1,148,000
Tasmania	209,000	143,000	77,000	72,000	190,000
New Zealand	1,032,000	1,069,000	848,000	732,000	1,731,000
Total Australasia	3,248,000	2,168,000	2,024,000	1,932,000	3,442,000
Total	915,504,000	895,491,000	801,757,000	949,420,000	841,970,000

Rye crop of the countries named, 1895–1899.

Countries.	1895.	1896.	1897.	1898.	1899.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
United States	27,210,000	24,369,000	27,363,000	25,658,000	23,962,000
Ontario	1,960,000	2,301,000	3,439,000	2,757,000	2,357,000
Manitoba	84,000	54,000	50,000	66,000	66,000
Rest of Canada	260,000	400,000	470,000	420,000	400,000
Total Canada	2,304,000	2,755,000	4,009,000	3,243,000	2,823,000
Total North America	29,514,000	27,124,000	31,372,000	28,901,000	26,785,000
Great Britain	1,619,000	2,065,000	1,709,000	1,782,000	----
Ireland	308,000	349,000	283,000	316,000	----
Total United Kingdom	1,927,000	2,414,000	1,992,000	2,098,000	2,000,000
Sweden	20,200,000	24,026,000	23,599,000	21,469,000	21,436,000
Denmark	18,399,000	20,081,000	18,116,000	16,132,000	18,000,000
Netherlands	12,796,000	13,571,000	11,930,000	11,000,000	11,500,000
Belgium	21,213,000	22,218,000	20,401,000	18,000,000	22,000,000
France	71,418,000	69,424,000	48,139,000	66,755,000	68,255,000
Spain	17,340,000	15,381,000	18,000,000	21,000,000	15,000,000
Italy	4,010,000	4,000,000	4,000,000	4,000,000	2,700,000
Germany	304,116,000	335,970,000	321,659,000	355,581,000	341,551,000
Austria	66,629,000	76,696,000	65,828,000	81,620,000	75,199,000
Hungary	45,066,000	48,426,000	35,309,000	43,179,000	47,268,000
Croatia-Slavonia	1,939,000	3,021,000	2,369,000	3,551,000	2,848,000
Total Austria-Hungary	113,634,000	128,143,000	103,506,000	128,350,000	125,315,000
Roumania	9,254,000	12,217,000	6,794,000	7,629,000	1,988,000
Bulgaria	7,200,000	4,800,000	10,000,000	14,400,000	10,000,000
Russia proper	717,964,000	700,983,000	567,466,000	636,467,000	805,230,000
Poland	54,746,000	61,845,000	54,228,000	72,029,000	67,580,000
North Caucasus	10,952,000	4,584,000	3,758,000	5,572,000	7,638,000
Total Russia in Europe	783,662,000	767,412,000	625,452,000	714,068,000	880,448,000
Total Europe	1,385,169,000	1,419,657,000	1,213,588,000	1,380,482,000	1,530,193,000
Siberia	17,003,000	21,154,000	27,994,000	22,627,000	30,523,000
Central Asia	613,000	994,000	833,000	804,000	660,000
Total Russia in Asia	17,616,000	22,148,000	28,827,000	23,431,000	31,183,000
Japan	35,913,000	30,321,000	31,563,000	33,709,000	34,000,000
Total	1,468,212,000	1,499,250,000	1,305,350,000	1,466,514,000	1,612,161,000

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	64,000
Oregon	99,500	56,000	75,000	71,250	85,000
Washington	28,800	12,000	32,000	36,200	33,000
New York	110,000	75,000	75,000	65,000	58,000
Total United States	290,300	178,000	227,000	216,950	240,000
Australia			18,383	18,383	*a* 7,218
Austria-Hungary	95,000	136,000	100,000	95,000	190,633
Belgium			85,734	30,630	*b* 70,311
England	343,000	281,000	255,784	218,000	411,554
France	42,000	43,000	88,184	42,867	25,545
Germany	368,000	353,000	584,498	440,9[illegible]0	407,199
Russia			64,000	61,240	41,057
Total	1,138,3[illegible]0	991,000	1,423,583	1,123,990	1,393,517

a New Zealand only. *b* Belgium and the Netherlands

Flax crop of the countries named, 1895–1899.

Countries.	Seed.			Fiber.		
	1896.	1897.	1898.	1896.	1897.	1898.
	Bushels.	*Bushels.*	*Bushels.*	*Pounds.*	*Pounds.*	*Pounds.*
United States *a*	17,402,000	11,000,000	17,217,000			
Manitoba	267,500	255,500	305,500			
Mexico	108,000	222,500	311,000			
Argentina *a*	7,500,000	7,000,000	9,000,000			
Total America	25,277,500	18,478,000	26,833,500			
Sweden	70,000	73,500	*d* 75,000	4,138,000	3,917,000	*d* 4,223,000
Netherlands	312,000	275,000	*d* 308,000	11,795,000	11,503,000	*d* 12,934,000
Belgium	394,000	350,000	*d* 400,000	31,417,000	30,123,000	*d* 32,246,000
France	523,000	524,000	357,000	41,549,000	41,224,000	25,126,000
Italy *b*				41,917,000	41,917,000	41,917,000
Austria	743,000	724,000	802,000	86,800,000	88,195,000	88,833,000
Hungary	245,000	220,000	250,000	11,972,000	10,629,000	14,939,000
Croatia-Slavonia	26,000	58,000	51,000	8,688,000	9,816,000	10,325,000
Total Austria-Hungary	1,014,000	1,002,000	1,103,000	107,460,000	108,640,000	114,097,000
Roumania	674,000	676,000	461,000			
Servia *c*				1,237,000	1,237,000	1,237,000
Russia	39,625,000	27,296,500	28,537,500	1,474,692,000	1,240,284,000	1,530,776,000
Total Europe	42,612,000	30,197,000	31,241,500	1,714,205,000	1,478,845,000	1,762,556,000
British India	14,795,000	8,839,500	17,839,000			

RECAPITULATION.

America	25,277,500	18,478,000	26,833,500			
Europe	42,612,000	30,197,000	31,241,500	1,714,205,000	1,478,845,000	1,762,556,000
British India	14,795,000	8,839,500	17,839,000			
Total	82,684,500	57,514,500	75,914,000	1,714,205,000	1,478,845,000	1,762,556,000

a Commercial estimate.
b Average, 1892 to 1895.
c Census 1893.
d Average for 3 preceding years.

Sugar crop of the countries named, 1895–1896 to 1899–1900.

[Tons of 2,240 pounds.]

Countries.	1895–1896.	1896–1897.	1897–1898.	1898–1899.	1899–1900.
CANE SUGAR.					
United States:					
Louisiana	237,720	282,009	310,447	245,511	132,000
Puerto Rico	50,000	58,000	54,000	53,825	50,000
Cuba, crop	240,000	219,500	314,009	345,261	395,000
British West Indies:					
Trinidad, exports	58,000	53,000	53,000	53,456	45,000
Barbadoes, exports	47,800	52,178	47,835	40,876	44,000
Jamaica	30,000	30,000	30,000	27,000	27,000
Antigua and St. Kitts	24,000	29,000	25,000	22,000	18,000
French West Indies:					
Martinique, exports	35,000	35,000	35,000	34,000	35,000
Guadeloupe	45,000	45,000	45,000	40,000	30,000
Danish West Indies:					
St. Croix	8,000	13,058	13,000	12,000	12,000
Haiti and San Domingo	50,000	48,800	48,000	50,000	55,000
Lesser Antilles (not named above)	8,000	8,000	8,000	8,000	8,000
Mexico, exports	2,000	2,000	2,000	2,000	2,000
Central America:					
Guatemala, crop	7,000	8,000	9,000	11,000	12,000
San Salvador, crop	2,000	3,000	4,000	4,500	5,000
Nicaragua, crop	500	500	1,500	3,750	4,000
Costa Rica, crop	200	200	500	750	1,000
South America:					
British Guiana (Demerara), exports	105,000	99,789	106,760	81,535	80,000
Dutch Guiana (Surinam), crop	6,000	6,000	6,000	6,000	6,000
Peru, exports	68,000	71,735	105,463	110,000	100,000
Argentine Republic, crop	130,000	165,000	110,000	72,000	90,000
Brazil, crop	225,000	175,903	200,478	151,495	175,000
Total in America	1,379,220	1,405,672	1,528,992	1,374,939	1,326,000
Asia: *a*					
British India, exports	80,000	28,000	20,000	10,000	10,000
Siam, crop	7,000	7,000	7,000	7,000	7,000
Java, exports	605,025	498,434	531,201	689,281	722,000
Philippine Islands, exports	230,000	202,000	178,000	76,000	40,000
Total in Asia	922,025	735,434	736,201	782,281	779,000
Australia and Polynesia:					
Queensland	60,000	100,774	97,916	163,734	122,500
New South Wales	32,000	31,000	26,000	28,000	15,000
Hawaiian Islands	201,632	224,218	204,833	252,506	275,000
Fiji Islands, exports	30,000	30,000	30,000	34,000	30,000
Total Australia and Polynesia	323,632	385,992	358,749	478,240	442,500
Africa:					
Egypt, crop	92,000	100,000	80,178	90,822	94,000
Mauritius	140,000	152,677	121,693	186,487	155,000
Reunion	44,700	45,082	31,483	37,781	35,000
Total in Africa	276,700	297,759	233,354	315,090	284,000
Europe:					
Spain	8,000	8,000	8,000	8,000	8,000
Total cane-sugar production, (Willett & Gray)	2,909,577	2,832,857	2,865,296	2,958,550	2,839,500
BEET SUGAR.					
Europe beet-sugar production (Licht):					
Germany	1,615,111	1,836,536	1,852,857	1,721,718	1,790,000
Austria	791,405	934,007	831,667	1,051,290	1,120,000
France	667,853	752,081	821,235	830,132	970,000
Russia	712,096	728,667	738,715	776,066	900,000
Belgium	235,795	288,009	265,397	244,017	300,000
Holland	106,829	174,206	125,658	149,763	180,000
Other countries	156,340	202,990	195,245	209,115	275,000
Total in Europe	4,285,429	4,916,496	4,831,774	4,982,101	5,535,000

a Japan, consumption 250,000 tons, mostly imported. China, consumption large, mostly imported.

Sugar crop of the countries named, 1895-1896 to 1899-1900—Continued.

Countries.	1895-1896.	1896-1897.	1897-1898.	1898-1899.	1899-1900.
BEET SUGAR—continued.					
United States beet-sugar production (Willett & Gray):					
California	21,877	28,200	31,381	16,436	37,938
Nebraska	3,743	5,246	6,579	4,721	4,591
Utah	3,600	3,640	1,641	5,764	8,574
New Mexico	----------	450	455	550	446
New York	----------	----------	342	1,030	1,607
Michigan	----------	----------	----------	2,253	14,699
Minnesota	----------	----------	----------	891	2,053
Oregon	----------	----------	----------	826	982
Illinois	----------	----------	----------	----------	804
Colorado	----------	----------	----------	----------	804
Washington	----------	----------	----------	----------	446
Total United States	29,220	37,536	40,398	32,471	72,944
Total cane and beet sugar	7,224,226	7,786,889	7,737,468	7,973,122	8,447,444

Rice crop of the countries named, 1895-1899.

Countries.	1894-95.	1895-96.	1896-97.	1897-98.	1898-99.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
North Carolina	4,000,000	2,720,000	2,720,000	2,080,000	2,560,000
South Carolina	22,364,800	27,901,440	29,532,160	28,395,200	23,054,720
Georgia	6,656,000	10,464,000	8,727,040	10,181,760	3,584,000
Louisiana	76,800,000	127,600,000	55,907,200	75,664,800	107,792,000
United States *a*	109,820,800	168,685,440	96,886,400	116,321,760	136,990,720
Mexico	27,173,862	87,614,694	46,755,161	*b* 43,261,948	*b* 43,261,948
North America	136,994,662	256,300,134	143,641,561	159,583,708	180,252,668
Spain	387,450,000	383,293,440	385,000,000	385,000,000	385,000,000
Italy	1,042,112,000	1,088,576,000	683,072,000	1,167,744,000	1,122,368,000
Europe	1,429,562,000	1,471,869,440	1,068,072,000	1,552,744,000	1,507,368,000
Bengal	46,688,006,400	35,516,635,200	20,119,388,800	44,591,904,000	47,863,849,600
Madras	3,994,211,200	6,312,264,000	5,416,286,400	5,375,070,400	6,182,803,200
Burma	5,082,781,760	4,645,872,000	5,340,048,000	5,848,304,000	4,858,448,000
India	55,764,999,360	46,474,771,200	30,875,723,200	55,815,278,400	58,905,100,800
Japan	12,974,286,650	11,764,925,575	10,737,770,225	15,300,991,450	13,481,647,725
Asia	68,739,286,010	58,239,696,775	41,613,493,425	71,116,269,850	72,386,748,525

RECAPITULATION.

North America	136,994,662	256,300,134	143,641,561	159,583,708	180,252,668
Europe	1,429,562,000	1,471,869,440	1,068,072,000	1,552,744,000	1,507,368,000
Asia	68,739,286,010	58,239,696,775	41,613,493,425	71,116,269,850	72,386,748,525
Total	70,305,842,672	59,967,866,349	42,825,206,986	72,828,597,558	74,074,369,193

a Figures from Dan Talmage's Sons. *b* Average 1893-1897.

Average yield per acre of the principal farm crops, 1890–1899.

[From Division of Statistics.]

CORN.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	36.2	37.5	35.5	30.3	39.9	42.0	37.0	37.0	40.0	36.0
New Hampshire	36.5	35.8	37.8	31.7	34.3	40.2	42.0	34.0	41.0	39.0
Vermont	33.5	37.2	38.0	32.4	40.8	45.6	41.0	35.0	43.0	36.0
Massachusetts	34.5	39.5	38.7	33.5	34.5	43.9	43.0	32.5	40.0	36.0
Rhode Island	32.7	34.5	33.4	24.4	31.4	30.9	34.0	31.0	34.0	31.0
Connecticut	35.7	36.0	34.5	28.2	31.0	37.9	38.0	31.5	37.0	39.0
New York	26.6	31.8	33.0	29.5	28.2	35.6	34.0	31.0	33.0	31.0
New Jersey	31.3	34.2	31.6	25.9	33.1	33.0	33.0	31.5	37.0	39.0
Pennsylvania	27.5	33.3	30.5	24.5	32.0	33.5	40.0	36.0	37.0	32.0
Delaware	18.5	22.0	18.7	24.6	22.0	21.0	22.0	29.0	25.0	22.0
Maryland	22.5	25.5	20.6	24.2	22.9	26.8	32.0	33.0	31.0	32.0
Virginia	17.5	19.7	15.3	18.9	19.1	18.6	21.5	18.0	22.0	20.0
North Carolina	13.3	14.1	10.2	12.3	13.4	14.5	12.0	13.0	14.0	13.0
South Carolina	10.2	11.6	10.5	7.7	11.2	11.1	9.0	9.0	10.0	9.0
Georgia	10.5	12.2	11.2	11.1	11.7	13.0	11.0	11.0	9.0	10.0
Florida	9.3	11.0	9.0	9.7	10.1	11.2	10.0	8.0	9.0	10.0
Alabama	10.2	12.7	12.2	11.5	13.7	15.9	12.5	12.0	15.0	12.0
Mississippi	12.5	15.2	13.7	13.1	17.2	15.8	13.5	14.5	18.0	16.0
Louisiana	16.0	17.3	14.8	14.2	16.2	18.8	13.0	17.0	18.0	18.0
Texas	15.5	19.5	21.4	17.6	19.0	26.4	9.5	18.5	25.0	18.0
Arkansas	16.7	21.2	17.5	16.2	19.2	21.5	13.5	16.0	20.0	20.0
Tennessee	18.8	22.7	20.3	21.3	21.9	25.0	23.0	21.0	26.0	20.0
West Virginia	20.0	27.3	22.5	21.7	18.5	24.2	30.0	24.5	29.0	26.0
Kentucky	22.6	30.0	23.3	23.5	23.0	31.2	28.0	23.0	31.0	21.0
Ohio	23.3	32.0	29.4	23.8	26.3	32.6	41.0	32.5	37.0	36.0
Michigan	27.2	29.5	25.0	23.7	23.2	33.8	38.0	31.5	34.0	25.0
Indiana	24.7	33.3	29.3	24.7	28.9	32.8	35.0	30.0	36.0	38.0
Illinois	26.2	33.5	26.2	25.7	28.8	37.4	40.5	32.5	30.0	36.0
Wisconsin	30.0	26.7	27.3	29.8	20.7	31.8	37.0	33.0	35.0	35.0
Minnesota	27.7	26.5	27.0	28.3	18.4	31.2	30.5	26.0	32.0	33.0
Iowa	26.5	36.7	28.3	33.9	15.0	35.1	39.0	29.0	35.0	31.0
Missouri	25.8	29.9	27.7	27.9	22.0	36.0	27.0	26.0	26.0	26.0
Kansas	15.6	26.7	24.5	21.3	11.2	24.3	28.0	18.0	16.0	27.0
Nebraska	18.0	35.2	28.2	25.2	6.0	16.1	37.5	30.0	21.0	28.0
South Dakota	13.6	22.5	22.3	23.7	4.2	11.1	26.0	24.0	28.0	26.0
North Dakota		18.0	21.4	20.7	19.2	21.3	35.0	17.0	19.0	23.0
Montana			19.4	27.5	32.7	25.0	26.0	18.0	28.0	23.0
Wyoming			18.5	18.5	30.0	27.5	25.0	12.0	16.0	22.0
Colorado	18.2	21.5	22.3	16.5	19.7	20.7	16.0	19.0	18.0	17.0
New Mexico	20.0	18.3	20.0	25.3	19.1	27.2	16.0	27.0	21.0	20.0
Utah	21.0	19.0	18.0	21.5	24.4	20.3	25.0	22.0	21.0	20.0
Washington			18.0	21.3	20.8	17.1	14.0	18.0	12.0	23.0
Oregon	21.6	27.0	21.5	24.7	25.4	26.4	22.0	25.0	24.0	22.0
California	27.5	34.5	30.3	31.7	19.3	34.5	37.0	31.5	26.0	27.0
Oklahoma										19.0
General average	20.70	27.03	23.06	22.48	19.38	26.21	28.19	23.76	24.76	25.31

WHEAT.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	13.5	16.3	16.7	16.0	21.1	19.2	22.0	16.5	19.5	22.5
New Hampshire	15.3	16.5	16.2	15.0	20.0	19.3	21.0	16.0	19.0	17.2
Vermont	17.2	17.5	17.3	16.8	22.7	29.0	24.5	17.0	22.5	22.0
Connecticut	16.1	17.0	16.7	18.3				20.0	20.0	18.3
New York	14.5	16.6	16.2	14.5	14.8	18.1	16.0	21.4	21.2	18.5
New Jersey	12.1	15.3	14.3	14.5	15.3	12.4	15.3	18.5	17.4	14.5
Pennsylvania	12.0	15.6	14.6	14.0	15.0	16.6	14.0	19.7	17.5	13.6
Delaware	9.7	12.8	13.0	14.7	13.0	11.6	18.0	21.5	13.3	12.8
Maryland	11.6	15.0	13.2	13.5	15.3	17.0	17.0	19.2	15.3	14.1
Virginia	7.0	9.0	9.5	11.2	9.5	9.3	9.3	12.0	14.1	8.4
North Carolina	4.4	6.8	7.1	8.2	5.0	6.9	7.3	8.0	9.2	6.7
South Carolina	4.2	5.5	6.5	6.3	5.6	6.4	6.8	8.7	10.6	6.5
Georgia	4.1	7.5	6.8	7.2	6.9	6.2	8.0	9.4	10.0	6.8
Alabama	4.5	8.0	6.7	8.2	8.3	7.5	8.0	10.0	12.0	7.6
Mississippi	4.7	7.8	6.8	7.5	9.8	8.0	8.5	10.0	13.9	7.7
Texas	7.0	12.0	12.3	10.5	15.1	5.7	11.7	15.8	14.8	11.1
Arkansas	7.1	9.6	8.2	8.0	8.8	9.4	8.0	10.5	11.0	8.6
Tennessee	6.7	9.7	9.5	9.2	8.1	8.8	8.5	11.2	13.2	8.7
West Virginia	7.7	10.3	10.7	11.5	12.1	10.6	10.3	13.4	13.8	9.3
Kentucky	9.7	12.7	11.8	11.3	12.5	10.9	8.7	13.6	15.4	9.1
Ohio	12.5	17.1	13.6	14.5	19.0	13.3	9.0	16.9	16.9	14.2
Michigan	13.5	18.8	14.7	13.2	15.8	13.2	12.8	15.6	20.8	8.4
Indiana	11.2	18.1	14.7	14.1	18.4	9.2	9.0	13.0	15.6	9.8
Illinois	9.8	18.0	16.2	11.5	18.2	11.0	14.7	7.9	11.0	10.0
Wisconsin	12.2	13.5	11.5	13.3	16.5	15.5	13.3	12.5	18.0	15.5

Average yield per acre of the principal farm crops, 1890-1899—Continued.

WHEAT—Continued.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Minnesota	12.2	17.6	11.6	9.6	13.5	23.0	14.2	13.0	15.8	13.4
Iowa	11.3	15.3	11.5	11.5	14.8	19.5	16.0	13.0	16.7	13.0
Missouri	11.0	13.6	12.5	9.5	15.3	12.0	11.7	9.0	9.8	9.9
Kansas	13.7	15.5	17.4	8.4	10.4	7.7	10.6	15.5	14.2	9.8
Nebraska	10.8	15.0	12.5	8.7	7.0	12.0	14.0	14.5	16.4	10.3
South Dakota	9.6	15.2	12.5	8.5	6.6	12.0	11.2	8.0	12.4	10.7
North Dakota		17.8	12.2	9.6	11.8	21.0	11.8	10.3	14.4	12.8
Montana	17.0	20.0	21.5	21.5	24.8	23.9	26.5	32.5	29.5	25.7
Wyoming	-------	20.0	17.5	18.7	19.6	26.0	24.5	25.0	23.7	18.8
Colorado	18.5	20.2	19.1	13.2	17.9	23.5	17.5	24.0	26.3	23.7
New Mexico	12.2	11.5	13.8	16.8	18.0	20.4	21.0	24.0	23.8	13.8
Arizona	12.0	14.5	15.6	17.5	17.0	20.5	23.0	18.0	31.7	15.3
Utah	17.5	17.5	17.3	13.8	22.0	22.4	26.5	21.0	28.0	20.7
Nevada	13.5	18.3	19.2	14.7	20.0	21.7	30.0	24.3	29.0	18.0
Idaho	16.5	20.0	22.0	19.3	20.6	17.8	24.5	22.0	31.0	24.2
Washington	18.5	17.5	17.2	20.3	16.6	15.5	18.0	23.5	24.2	22.7
Oregon	14.5	19.0	15.7	17.5	17.7	20.0	17.0	17.0	20.5	19.2
California	12.0	13.0	13.0	13.3	11.3	13.0	14.6	10.0	9.1	14.1
Oklahoma	-------	-------	-------	-------	11.3	11.4	13.0	19.0	14.9	13.3
General average	11.06	15.33	13.38	11.44	13.19	13.72	12.35	13.43	15.33	12.27

OATS.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	28.3	34.6	32.2	36.3	33.5	40.1	40.0	31.0	36.0	35.0
New Hampshire	27.5	35.0	31.0	34.2	31.1	36.9	38.0	35.0	33.0	35.0
Vermont	26.2	37.5	35.5	36.4	32.9	43.8	40.5	33.0	38.0	37.0
Massachusetts	25.7	33.0	30.4	34.3	31.9	36.0	36.0	32.0	32.0	33.0
Rhode Island	23.4	33.5	29.4	28.2	30.0	32.4	30.0	32.0	27.0	26.0
Connecticut	20.0	30.0	25.3	25.0	25.8	31.9	29.0	29.0	28.2	28.0
New York	17.8	31.5	28.0	24.0	22.1	31.7	33.0	31.0	27.5	31.0
New Jersey	17.3	28.0	25.7	23.9	28.4	35.5	34.0	25.0	19.6	24.0
Pennsylvania	17.2	27.2	25.2	26.8	22.3	31.7	31.0	28.2	23.3	33.0
Delaware	13.0	20.3	19.3	25.4	19.0	19.1	29.0	22.0	22.0	20.0
Maryland	12.0	19.0	19.0	21.2	21.4	26.2	24.0	24.0	19.5	23.0
Virginia	9.8	10.7	11.2	17.5	12.0	17.7	18.5	12.0	16.1	14.0
North Carolina	9.2	9.5	9.7	14.1	10.9	15.1	12.0	13.0	14.3	12.0
South Carolina	10.6	10.6	10.5	11.8	12.0	15.2	11.0	15.5	17.2	12.0
Georgia	9.7	11.7	10.7	13.3	13.4	14.5	12.0	14.0	16.6	9.0
Florida	10.7	11.4	9.8	11.8	11.8	10.2	12.0	9.0	15.4	9.0
Alabama	12.0	12.8	10.2	14.2	13.2	14.9	14.0	13.0	16.8	10.0
Mississippi	13.2	11.5	10.6	15.5	13.0	15.7	13.0	14.0	18.5	10.0
Louisiana	13.2	12.3	12.2	16.0	22.3	15.0	10.0	18.0	18.1	18.0
Texas	17.3	24.5	24.5	25.1	32.7	20.7	20.0	25.0	29.7	25.0
Arkansas	13.5	16.5	15.7	19.3	18.5	25.4	16.0	17.0	22.8	19.0
Tennessee	9.5	9.7	13.5	18.4	14.6	22.5	16.5	10.0	18.7	14.0
West Virginia	10.6	17.3	17.5	23.5	18.5	23.4	24.0	20.0	19.5	23.0
Kentucky	8.5	18.5	18.3	22.2	21.0	26.2	21.0	18.0	22.4	18.0
Ohio	18.0	31.3	26.3	28.6	30.3	31.7	31.0	32.0	30.9	36.0
Michigan	26.6	32.5	28.7	26.0	26.1	23.9	30.0	26.0	32.8	34.0
Indiana	17.5	23.5	26.5	27.5	32.3	22.9	29.0	30.2	29.2	32.0
Illinois	21.0	36.2	26.3	27.2	36.1	24.4	28.0	32.0	29.0	38.0
Wisconsin	26.0	33.3	30.2	27.6	32.9	33.8	33.4	34.0	36.1	36.0
Minnesota	25.6	36.5	27.3	24.8	28.1	39.9	33.0	26.0	36.3	32.0
Iowa	25.8	36.7	25.4	24.8	25.6	46.2	27.5	30.0	34.0	33.0
Missouri	17.4	23.8	20.0	23.4	23.3	27.7	18.0	22.0	17.0	25.0
Kansas	24.0	30.0	28.5	18.5	17.9	17.9	13.0	24.0	18.0	29.0
Nebraska	21.3	35.5	26.7	15.0	12.6	23.8	19.0	31.0	32.1	30.0
South Dakota	21.0	32.3	26.3	21.5	7.6	25.3	27.5	22.0	26.8	26.0
North Dakota		33.5	26.5	21.9	25.9	32.1	22.0	23.0	30.7	30.0
Montana	31.0	38.5	28.8	34.0	40.1	35.8	47.0	42.0	40.6	38.0
Wyoming	-------	-------	28.6	24.0	30.4	41.0	32.0	35.0	31.2	30.0
Colorado	24.8	32.6	28.7	26.7	13.5	34.3	28.0	34.0	35.8	27.0
New Mexico	24.0	22.0	20.3	29.2	35.0	39.9	27.0	35.5	33.8	24.0
Utah	27.5	32.5	26.5	27.9	33.0	33.8	38.0	35.0	39.7	34.0
Idaho	30.0	35.0	29.0	33.1	38.5	35.2	42.0	36.3	43.6	34.0
Washington	33.5	38.0	34.5	39.7	36.5	40.3	36.0	48.0	41.9	37.0
Oregon	30.0	31.5	26.5	28.5	26.7	28.8	21.0	32.0	27.0	30.0
California	27.5	28.5	29.3	25.5	35.6	28.1	31.0	18.0	33.0	31.0
General average	19.81	28.86	24.43	23.42	24.50	29.57	25.66	27.16	28.35	30.23

Average yield per acre of the principal farm crops, 1890–1899—Continued.

BARLEY.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	20.0	26.5	22.3	26.1	26.1	32.4	30.6	25.0	27.0	29.0
New Hampshire	20.0	26.3	23.5	25.3	24.4	25.6	29.3	22.5	23.5	25.0
Vermont	22.5	27.8	26.0	27.5	27.9	33.2	33.0	28.5	30.0	31.0
Massachusetts	22.0	26.7	22.5	25.3	21.7	22.5	30.0	34.5	24.5	30.0
Rhode Island	21.7	28.0	21.5	25.2	30.0	23.5	29.0	28.0	28.0	29.0
New York	16.7	23.3	22.2	20.3	17.5	22.9	23.2	25.0	25.2	24.0
Pennsylvania	......	22.5	21.7	19.0	16.6	20.2	17.2	24.5	19.4	21.0
Texas	15.0	15.2	16.5	14.5	15.3	21.6	12.0	25.0	20.0	18.0
Tennessee	......	12.7	19.5	15.1	13.8	23.1	14.0	18.0	18.0	11.0
Kentucky	19.0	24.5	22.3	17.0	28.7	33.3	14.8	20.0	16.0	21.0
Ohio	19.5	25.7	23.5	22.7	28.5	28.2	20.2	28.5	28.7	28.0
Michigan	22.3	24.5	23.4	16.4	20.6	18.1	22.3	21.5	25.2	24.0
Indiana	16.5	23.5	28.0	19.9	20.7	15.0	20.3	19.0	23.4	25.0
Illinois	20.3	26.0	17.9	23.2	23.5	20.0	23.7	25.0	27.3	29.0
Wisconsin	22.7	26.5	25.5	24.0	28.6	29.3	27.4	28.0	29.1	30.0
Minnesota	22.5	27.3	24.9	22.1	23.5	36.0	27.2	25.5	28.4	25.0
Iowa	22.6	27.3	21.1	22.6	15.5	28.0	26.3	24.0	26.0	26.0
Missouri	20.0	......	29.1	20.0	14.0	15.3	17.5	19.0	20.0	18.0
Kansas	18.0	26.5	25.0	8.1	8.8	14.4	4.6	17.5	28.0	17.0
Nebraska	17.3	27.2	22.2	12.0	5.7	28.4	19.9	22.0	27.1	26.0
South Dakota	19.5	28.5	23.3	15.4	14.7	19.5	28.5	20.0	23.0	23.0
North Dakota		30.0	24.3	15.2	20.1	30.4	16.1	22.5	26.4	24.0
Montana	24.0	30.0	32.5	30.1	22.5	25.0	25.0	38.0	36.0	35.0
Colorado	24.5	26.5	24.0	28.3	27.8	31.3	20.0	28.0	30.5	28.0
New Mexico	20.0	22.0	19.6	21.6	27.0	28.0	19.0	32.5	33.8	32.0
Utah	23.2	26.7	20.3	37.6	33.0	30.0	27.1	31.0	37.0	33.0
Idaho	......	29.0	26.0	30.0	32.6	24.5	15.3	35.0	35.0	35.0
Washington	25.0	31.5	25.3	40.1	33.7	37.3	26.0	45.0	39.8	35.0
Oregon	25.0	24.0	23.3	26.1	38.6	22.1	21.8	32.5	29.1	28.0
California	22.3	23.7	24.0	22.5	15.2	20.3	21.6	23.0	10.5	26.0
General average	21.60	25.80	23.70	21.70	19.37	26.39	23.62	24.52	21.60	25.50

RYE.

	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	11.8	16.0	13.5	12.0	16.5	19.2	18.0	13.5	18.0	15.0
New Hampshire	12.5	16.2	14.0	15.1	15.4	16.0	19.6	18.0	17.5	15.0
Vermont	12.9	16.1	14.3	14.0	13.1	16.0	18.6	16.0	19.1	17.0
Massachusetts	13.5	15.3	15.2	16.2	19.2	19.9	22.0	19.5	16.7	16.0
Connecticut	12.2	14.3	14.3	15.9	12.9	16.9	15.4	19.0	18.0	18.0
New York	12.3	15.0	12.7	14.9	15.4	18.1	14.3	18.5	17.5	16.0
New Jersey	11.3	14.3	13.5	13.4	14.8	13.6	13.8	17.0	15.5	15.0
Pennsylvania	12.2	14.8	12.6	14.7	13.9	15.1	16.0	19.0	16.1	15.0
Maryland	10.3	12.2	11.3	13.1	13.5	12.9	9.2	17.0	14.5	14.0
Virginia	6.6	8.2	8.8	9.3	8.8	11.0	10.0	11.0	11.2	9.0
North Carolina	5.7	7.0	6.5	7.7	9.0	7.7	7.5	8.8	9.1	7.0
South Carolina	5.4	6.0	6.0	5.4	4.7	9.3	4.8	6.6	8.5	5.0
Georgia	4.9	7.6	6.0	6.4	6.5	7.2	7.1	7.4	8.0	6.0
Alabama	7.2	7.5	6.5	9.8	13.3	10.2	8.0	9.6	11.1	8.0
Texas	5.5	11.2	11.2	9.3	11.3	5.5	7.0	12.0	12.0	10.0
Arkansas	6.5	9.3	8.2	7.5	9.0	10.0	10.0	11.0	11.4	11.0
Tennessee	6.3	8.7	8.7	9.5	7.6	7.2	9.0	10.0	10.5	9.0
West Virginia	9.5	10.5	9.5	8.2	8.0	16.1	10.6	11.5	11.2	10.0
Kentucky	9.5	10.3	11.3	13.2	12.2	13.2	11.0	13.0	13.0	10.0
Ohio	11.7	15.5	12.6	15.2	18.3	14.8	9.6	18.0	17.4	16.0
Michigan	13.4	15.0	13.7	12.8	13.2	13.6	9.2	15.0	15.3	14.0
Indiana	13.7	17.2	12.5	14.4	19.3	12.2	10.6	13.0	15.5	13.0
Illinois	12.7	17.5	12.3	13.9	18.6	15.2	15.3	15.5	14.8	15.0
Wisconsin	12.5	14.6	13.7	14.5	16.0	16.1	14.5	16.0	15.3	15.0
Minnesota	14.0	17.2	17.1	15.3	17.5	21.1	15.6	17.2	20.5	18.0
Iowa	13.7	17.0	13.2	14.6	16.9	20.6	17.5	16.0	19.0	18.0
Missouri	12.7	13.5	12.5	12.8	15.4	12.2	12.2	12.0	13.1	13.0
Kansas	13.0	14.3	15.0	7.0	5.8	5.9	7.0	14.0	15.6	11.0
Nebraska	13.2	15.7	14.5	10.1	6.1	9.3	16.9	17.0	18.8	16.0
South Dakota	11.7	15.3	12.5	10.6	4.5	8.4	11.6	16.5	16.6	15.0
North Dakota		17.5	11.8	12.3	15.0	21.3	12.0	14.5	15.0	15.0
Colorado	14.5	20.6	14.6	21.0	15.6	14.5	23.5	15.0	18.0	14.0
Utah	13.5	16.8	13.2	11.9	19.0	19.8	20.0	12.0	19.5	17.0
Washington	14.2	14.3	17.0	15.1	14.4	26.7	15.0	19.5	18.0	16.0
Oregon	14.3	13.8	12.0	10.5	14.1	11.2	12.7	15.0	14.4	11.0
California	14.0	16.5	11.5	17.5	13.2	11.6	14.3	12.2	9.0	15.0
General average	11.80	14.40	12.70	13.03	13.74	14.40	13.31	16.06	15.61	14.44

Average yield per acre of the principal farm crops, 1890–1899—Continued.

BUCKWHEAT.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	20.0	22.0	19.0	29.0	37.8	38.6	42.3	35.0	26.5	22.0
New Hampshire	18.0	21.5	17.5	23.2	20.0	29.9	27.2	27.0	20.0	20.0
Vermont	20.0	22.5	20.0	29.2	22.4	34.5	31.4	24.0	21.4	23.0
Massachusetts	17.5	16.5	11.5	27.5	18.9	15.0	18.3	19.0	20.0	20.0
Connecticut	14.7	16.0	12.0	15.8	16.4	15.4	14.2	17.0	19.0	19.0
New York	15.5	17.5	14.7	14.4	15.5	21.4	18.8	22.0	16.8	13.0
New Jersey	14.0	14.2	12.5	14.4	14.4	18.7	20.7	16.0	21.0	21.0
Pennsylvania	13.5	13.6	14.5	14.1	18.0	19.9	17.3	21.0	17.2	20.0
Delaware	......	......	......	20.0	20.0	10.0	20.0	19.0	16.5	18.0
Maryland	12.0	12.5	12.5	11.8	20.0	10.9	22.7	19.0	12.2	13.0
Virginia	9.5	12.5	8.3	13.3	14.7	10.1	18.0	14.0	17.3	14.0
North Carolina	11.0	11.5	7.2	11.5	18.7	12.0	20.0	11.0	19.5	17.0
Tennessee	10.0	......	7.5	12.6	12.8	10.0	24.0	18.0	18.0	12.0
West Virginia	12.0	13.5	16.3	11.5	22.6	18.8	19.5	19.0	20.5	17.0
Ohio	12.0	15.5	12.6	12.0	14.9	14.6	18.8	18.0	20.0	16.0
Michigan	16.5	14.2	13.0	13.9	12.0	17.2	15.3	17.0	14.2	11.0
Indiana	15.0	13.2	11.5	6.9	14.8	14.3	24.0	14.0	18.4	16.0
Illinois	14.5	14.0	11.3	11.6	11.7	13.3	13.8	13.0	14.0	15.0
Wisconsin	14.3	9.5	13.5	15.8	8.5	17.9	13.5	18.0	15.5	15.0
Minnesota	12.8	12.5	13.8	15.2	9.2	15.3	10.6	17.0	15.0	17.0
Iowa	14.2	13.5	10.7	13.2	13.6	13.5	16.2	17.0	16.0	16.0
Missouri	13.2	12.5	11.3	12.7	9.2	10.2	21.8	15.0	15.8	14.0
Nebraska	12.0	12.0	8.2	14.7	3.7	6.7	21.3	14.0	12.8	16.0
Oregon	16.0	......	11.2	20.0	38.0	15.5	21.0	18.0	14.0	17.0
General average	14.50	15.30	14.10	14.86	16.05	20.10	18.66	20.89	17.28	16.56

POTATOES.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*
Maine	95	125	82	120	147	163	165	59	130	139
New Hampshire	90	110	80	119	120	134	108	51	90	127
Vermont	95	120	54	111	124	154	128	70	105	132
Massachusetts	87	120	83	119	105	133	108	62	97	134
Rhode Island	90	120	95	108	133	128	105	110	123	142
Connecticut	80	92	82	87	79	128	106	54	100	130
New York	62	87	63	70	77	122	89	62	73	88
New Jersey	76	98	71	73	60	94	94	68	75	83
Pennsylvania	68	84	60	76	64	111	109	63	54	85
Delaware	70	76	42	50	50	58	78	60	49	52
Maryland	70	78	60	49	52	87	90	74	58	64
Virginia	68	76	58	74	59	73	93	61	68	66
North Carolina	73	75	55	97	62	79	79	66	67	57
South Carolina	63	69	70	83	59	90	52	65	65	56
Georgia	72	74	70	74	52	58	55	52	54	46
Florida	75	74	65	87	90	55	75	75	64	69
Alabama	67	67	65	83	43	70	64	55	74	56
Mississippi	61	60	67	81	72	58	70	59	74	61
Louisiana	63	73	65	67	45	89	55	64	78	60
Texas	67	69	61	53	80	89	52	60	78	64
Arkansas	60	75	63	88	82	70	59	55	74	63
Tennessee	62	70	67	68	55	64	62	40	52	44
West Virginia	58	88	60	80	52	69	93	56	62	72
Kentucky	33	78	58	68	54	86	85	47	64	51
Ohio	46	98	60	58	63	63	89	42	61	71
Michigan	58	96	62	75	62	101	88	72	79	66
Indiana	37	93	56	51	59	66	85	31	71	76
Illinois	30	92	52	53	50	77	97	38	70	96
Wisconsin	60	93	65	77	45	107	78	99	98	103
Minnesota	68	160	70	66	39	158	84	106	85	96
Iowa	48	99	51	58	43	106	94	60	80	100
Missouri	39	96	51	78	69	109	78	42	66	83
Kansas	28	88	47	44	41	72	69	48	70	95
Nebraska	27	97	48	44	22	67	90	65	65	94
South Dakota	45	91	64	54	23	66	96	94	72	78
North Dakota		105	75	69	84	128	102	99	87	103
Montana	......	120	100	138	111	53	170	156	104	141
Wyoming	......	100	100	134	150	100	167	150	120	125
Colorado	73	115	99	94	85	95	88	97	77	84
New Mexico	80	85	35	70	75	80	72	90	58	49
Utah	85	105	59	88	135	172	155	148	135	120
Nevada	95	98	100	132	161	150	190	135	155	102
Idaho	......	115	98	153	178	105	162	140	120	124
Washington	115	125	100	120	125	149	125	162	108	144
Oregon	100	110	70	127	112	64	87	160	86	115
California	95	95	75	96	52	75	80	105	95	119
General average	57.50	93.90	62.00	70.26	62.38	100.59	91.14	64.71	75.19	88.63

Average yield per acre of the principal farm crops, 1890–1899—Continued.

HAY.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Maine	1.00	0.95	0.90	0.92	0.95	1.02	1.09	1.10	1.20	0.90
New Hampshire	1.05	.92	.90	1.06	.95	.95	.96	1.15	1.25	.89
Vermont	1.08	1.60	.95	1.11	1.20	1.07	1.25	1.30	1.45	1.14
Massachusetts	1.00	1.10	1.10	1.15	1.26	1.11	1.28	1.40	1.42	1.13
Rhode Island	1.12	.85	.90	.83	.75	.91	1.10	1.15	1.18	.89
Connecticut	1.20	.90	1.00	.99	.87	.85	1.07	1.20	1.31	.94
New York	1.25	1.10	1.10	1.24	1.17	.73	.81	1.35	1.40	1.04
New Jersey	1.30	1.05	1.07	.99	1.16	1.21	1.15	1.75	1.42	.83
Pennsylvania	1.25	1.15	1.10	1.03	1.18	1.01	1.06	1.40	1.45	1.20
Delaware	1.20	1.10	1.00	.75	1.30	1.23	1.10	1.35	1.38	1.04
Maryland	1.25	1.12	.98	1.04	1.03	1.25	.87	1.35	1.20	1.13
Virginia	1.27	1.13	.95	1.11	.72	1.13	1.08	1.08	1.32	1.10
North Carolina	1.35	1.10	1.20	1.70	1.45	1.63	1.26	1.25	1.70	1.50
South Carolina	1.37	1.15	1.20	1.57	1.53	1.00	1.33	1.00	1.60	1.22
Georgia	1.35	1.17	1.35	1.32	1.16	1.60	1.38	1.35	1.75	1.45
Florida	1.28	.....	....	2.60	1.23	1.53	1.40	1.00	1.60	1.46
Alabama	1.25	1.30	1.30	1.52	2.68	1.56	1.40	1.45	1.90	1.66
Mississippi	1.30	1.30	1.35	1.65	1.84	1.95	1.35	1.48	1.90	1.44
Louisiana	1.30	1.30	1.40	1.62	1.96	2.02	1.90	1.90	2.10	1.95
Texas	1.00	1.31	1.05	1.04	1.33	1.48	1.00	1.40	1.50	1.43
Arkansas	1.10	1.30	1.15	1.17	1.32	1.20	1.18	1.30	1.54	1.48
Tennessee	1.15	1.20	1.10	1.39	1.18	1.39	1.40	1.45	1.50	1.31
West Virginia	1.15	1.18	1.00	1.10	1.02	.71	1.22	1.35	1.54	1.29
Kentucky	1.25	1.18	1.15	1.33	1.26	1.35	1.20	1.17	1.45	1.29
Ohio	1.30	1.20	1.15	1.33	1.27	.58	1.26	1.44	1.39	1.30
Michigan	1.25	1.15	1.20	1.46	1.20	.58	1.16	1.49	1.36	1.22
Indiana	1.30	1.20	1.20	1.36	1.27	.61	1.30	1.43	1.45	1.34
Illinois	1.30	1.25	1.25	1.21	1.14	.66	1.38	1.29	1.56	1.29
Wisconsin	1.25	1.12	1.20	1.52	1.31	.88	1.25	1.35	1.50	1.47
Minnesota	1.35	1.15	1.25	1.62	1.02	1.30	1.69	1.57	1.80	1.70
Iowa	1.20	1.20	1.25	1.58	.73	1.08	1.74	1.50	1.75	1.34
Missouri	1.20	1.15	1.15	1.24	.85	1.17	1.43	1.15	1.60	1.37
Kansas	.80	1.30	1.10	1.31	.77	1.24	1.42	1.30	1.46	1.57
Nebraska	.85	1.20	1.20	1.25	.59	.99	1.66	1.60	1.60	1.65
South Dakota	.86	1.21	1.25	1.42	.94	.79	1.28	1.25	1.38	1.43
North Dakota		1.15	1.30	1.29	1.19	1.42	1.65	1.60	1.50	1.58
Montana	......	1.15	1.10	1.26	1.20	.94	1.38	1.50	1.45	1.42
Wyoming	....	.93	1.15	1.35	1.60	1.08	1.55	1.65	1.96	1.47
Colorado	1.37	1.88	2.00	1.19	2.27	2.42	2.29	2.25	2.20	2.10
New Mexico	1.13	1.10	1.20	2.08	1.88	2.61	3.00	3.50	3.75	1.70
Arizona		....	1.30	1.75	1.82	1.85	3.20	3.00	3.50	2.63
Utah	1.38	1.40	1.40	1.72	2.52	2.56	2.70	2.95	3.25	2.50
Nevada	1.20	1.20	1.75	2.66	4.04	3.01	2.55	2.50	2.60	1.87
Idaho	....	1.20	1.50	2.45	2.53	2.57	2.60	2.30	3.75	2.50
Washington	1.40	1.45	1.40	1.58	2.05	1.85	1.95	2.25	1.75	2.02
Oregon	1.50	1.30	1.45	1.88	2.00	1.78	1.98	1.90	1.90	1.97
California	1.40	1.40	1.50	1.69	1.93	1.66	1.65	1.60	1.60	1.63
General average	1.20	1.18	1.18	1.33	1.14	1.06	1.37	1.43	1.55	1.35

COTTON.

States and Territories.	1890–91	1891–92	1892–93	1893–94	1894–95	1895–96	1896–97	1897–98	1898–99
	Bales.	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*	*Bales.*
Virginia	....	....	....	....	0.21	0.18	0.24	0.25	0.27
North Carolina	....	....	....	0.34	.35	.38	.42	.50	.48
South Carolina	....	....	....	.34	.38	.42	.46	.50	.44
Georgia	....	....	....	.33	.33	.35	.37	.38	.39
Florida	....	....	....	.33	.24	.20	.18	.21	.23
Alabama	....	....	....	.35	.32	.28	.31	.41	.39
Mississippi	....	....	....	.37	.41	.41	.42	.55	.43
Louisiana	....	....	....	.50	.55	.45	.46	.63	.56
Texas	....	....	....	.48	.45	.33	.31	.39	.48
Arkansas	....	....	....	.36	.48	.44	.39	.58	.49
Tennessee	....	....	....	.34	.33	.24	.26	.28	.36
Missouri	....	....	....	....	.38	.25	.31	.32	.40
Oklahoma	....	....	....	....	.45	.54	.45	.51	.50
Indian Territory	....	....	....	....	.45	.32	.62	.65	.66
General average	.416	.436	.371	.387	.418	.355	.367	.448	.448

Average value per acre of principal farm crops, 1890–1899

CORN.

[From Division of Statistics.]

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Maine	$26.79	$30.00	$23.79	$18.79	$28.73	$22.68	$17.39	$17.39	$19.20	$18.00
New Hampshire	26.28	27.57	24.57	18.07	26.07	20.50	18.90	15.30	18.86	19.11
Vermont	24.12	28.27	24.32	19.76	28.15	21.89	15.58	15.05	18.92	16.92
Massachusetts	24.15	30.81	23.99	20.77	21.05	22.83	19.78	15.28	19.60	18.35
Rhode Island	23.54	27.26	21.04	16.84	23.55	17.30	16.66	16.74	21.76	16.43
Connecticut	24.99	27.36	21.39	18.05	21.08	19.33	15.96	15.43	19.24	19.50
New York	17.29	20.99	19.80	16.23	17.20	16.02	12.92	12.40	14.19	13.95
New Jersey	19.41	22.23	18.33	13.47	17.87	13.86	11.88	11.97	14.80	15.60
Pennsylvania	16.50	18.98	17.38	12.00	17.60	13.07	13.20	22.24	14.80	13.12
Delaware	9.25	12.10	8.23	9.84	9.90	7.14	5.50	8.70	7.75	7.48
Maryland	11.25	13.52	9.27	10.64	11.45	9.92	10.24	9.90	10.85	11.52
Virginia	9.62	9.85	8.11	8.69	8.98	6.88	6.88	6.84	7.70	7.60
North Carolina	7.32	8.18	5.51	6.15	6.30	5.51	4.44	5.59	6.02	6.11
South Carolina	7.14	8.12	5.99	4.62	7.28	5.11	4.14	4.41	4.60	4.50
Georgia	7.24	8.42	6.27	6.22	6.79	5.33	4.73	5.28	4.32	5.00
Florida	6.97	8.80	5.40	6.60	7.17	5.26	5.30	4.40	4.50	5.30
Alabama	6.94	8.00	6.34	6.79	7.26	5.88	5.63	5.52	6.15	5.64
Mississippi	8.75	8.82	6.99	7.20	8.43	5.85	5.94	6.53	7.02	7.36
Louisiana	11.20	10.38	7.40	8.09	10.04	7.24	5.85	7.65	7.38	7.92
Texas	11.16	10.73	9.63	9.50	10.64	8.18	3.90	7.58	8.50	6.48
Arkansas	10.86	9.75	8.23	7.29	9.02	6.88	4.99	6.40	5.80	7.60
Tennessee	9.78	9.76	8.73	8.31	8.54	6.75	6.44	7.56	7.54	7.80
West Virginia	12.00	14.20	12.60	11.94	10.55	9.68	10.20	9.80	10.73	11.70
Kentucky	11.07	12.00	9.32	10.11	10.12	8.42	7.00	8.05	8.37	7.77
Ohio	11.88	13.12	12.35	9.52	11.31	8.80	8.61	8.12	9.99	10.80
Michigan	14.96	14.16	11.50	10.66	11.60	10.82	9.12	8.50	11.56	9.00
Indiana	11.61	12.65	11.72	8.89	10.69	7.54	6.65	6.30	9.00	10.26
Illinois	11.27	12.40	9.69	7.97	11.23	8.23	7.29	6.83	7.50	9.36
Wisconsin	13.50	11.75	10.37	10.43	9.32	9.54	8.14	8.25	9.80	10.50
Minnesota	11.63	10.33	9.99	9.62	7.91	6.24	5.79	6.24	7.68	7.92
Iowa	10.87	11.01	9.06	9.15	6.75	6.32	5.46	4.93	8.05	7.13
Missouri	11.35	11.36	9.97	8.37	8.80	7.20	5.40	6.24	7.02	7.80
Kansas	7.96	9.08	7.60	6.60	4.82	4.62	5.04	3.96	4.16	6.75
Nebraska	8.64	9.15	7.90	6.80	3.00	2.90	4.88	5.10	4.62	6.44
South Dakota	6.80	7.88	7.36	5.93	1.93	2.55	4.68	5.04	6.44	6.76
North Dakota		7.20	8.56	7.87	8.45	5.11	8.75	5.44	6.84	7.59
Montana	------	------	13.30	19.25	26.81	18.75	15.60	11.70	18.48	11.96
Wyoming	------	------	11.28	11.66	19.50	15.67	19.50	6.00	8.80	9.46
Colorado	11.47	11.40	8.92	8.42	12.02	8.49	5.76	7.22	7.20	7.31
New Mexico	14.60	13.18	14.40	17.96	14.33	15.23	8.80	15.66	11.76	11.60
Utah	14.28	11.40	10.44	12.47	14.15	9.95	12.75	12.10	12.60	11.80
Washington	------	------	10.80	13.21	14.35	6.84	7.98	9.90	5.04	12.65
Oregon	14.26	19.17	12.04	11.61	14.22	14.52	12.32	13.25	14.40	14.03
California	17.87	24.50	16.67	15.85	11.00	18.29	19.61	17.64	16.12	16.20
Oklahoma	------	------	------	------	------	------	------	------	------	3.80
General average	10.48	10.98	9.09	8.21	8.86	6.64	6.06	6.26	7.10	7.66

WHEAT.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Maine	$15.53	$17.93	$17.03	$16.32	$16.67	$15.74	$18.48	$17.49	$17.36	$20.47
New Hampshire	17.60	18.98	16.30	12.75	16.00	14.67	21.00	17.60	17.48	16.34
Vermont	19.09	19.95	16.51	14.28	15.21	20.01	22.79	17.68	20.25	18.70
Connecticut	17.60	17.85	14.53	------	------	------	------	20.00	17.60	17.39
New York	14.50	16.60	13.77	11.02	9.18	12.31	14.08	19.26	15.26	14.80
New Jersey	12.10	15.91	11.87	10.15	9.33	8.80	13.62	17.20	12.70	10.88
Pennsylvania	11.88	15.60	11.83	9.10	8.40	10.79	11.62	17.93	11.90	8.98
Delaware	9.31	12.80	9.75	8.82	7.15	7.42	15.66	20.21	9.18	8.70
Maryland	10.67	15.00	9.77	10.26	8.26	10.88	14.96	17.86	10.71	9.59
Virginia	6.72	9.00	7.22	7.06	5.32	6.05	7.44	11.04	9.31	5.80
North Carolina	4.40	6.94	6.32	5.90	3.25	4.97	6.06	7.52	7.18	5.49
South Carolina	4.41	6.05	6.04	6.17	4.87	5.63	6.05	10.27	9.96	6.44
Georgia	4.51	8.25	6.12	6.48	5.24	5.08	7.12	9.68	9.80	6.66
Alabama	4.91	8.80	6.23	7.22	6.47	6.00	6.80	10.10	10.80	6.76
Mississippi	5.17	7.80	6.12	6.55	7.35	4.88	6.97	9.90	11.54	6.01
Texas	6.65	10.44	9.23	6.09	8.15	3.76	8.78	14.06	10.08	7.55
Arkansas	6.96	8.64	6.56	5.20	4.84	5.55	5.68	8.82	6.38	5.50
Tennessee	6.50	9.02	6.46	5.24	4.13	5.46	6.29	10.64	8.84	6.79
West Virginia	7.31	9.89	8.03	8.28	7.26	7.31	8.03	11.93	9.80	6.60
Kentucky	8.92	11.43	7.91	6.44	6.25	6.65	6.61	12.10	9.55	6.01
Ohio	11.38	15.73	9.25	8.27	9.31	7.98	7.02	14.87	11.15	9.09
Michigan	12.15	17.11	9.85	7.52	8.22	7.92	10.75	13.57	13.31	5.46
Indiana	9.86	15.57	9.41	7.47	8.46	5.24	7.20	11.57	9.83	6.27
Illinois	8.53	15.30	10.21	5.87	8.19	5.83	10.88	7.03	6.00	6.30
Wisconsin	10.13	11.34	7.13	7.18	8.42	7.91	9.31	10.50	10.62	9.46
Minnesota	9.88	13.73	7.08	4.90	6.62	10.12	9.66	10.01	8.53	7.37
Iowa	9.04	12.39	6.90	5.64	7.40	8.97	9.92	9.75	8.68	7.15

Average value per acre of principal farm crops, 1890–1899—Continued.

WHEAT—Continued.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Missouri	$9.13	$10.88	$7.25	$4.56	$6.58	$6.12	$8.19	$7.65	$5.78	$6.14
Kansas	10.55	11.31	9.05	3.53	4.58	3.47	6.68	11.47	7.10	5.10
Nebraska	8.21	10.95	6.25	3.48	3.43	4.80	8.12	10.00	7.71	5.05
South Dakota	6.72	10.94	6.38	3.74	3.04	4.56	6.94	5.52	6.20	5.35
North Dakota		12.46	6.34	4.13	5.07	7.98	7.55	7.62	7.34	6.53
Montana	13.69	16.80	14.84	12.90	13.39	17.45	17.49	22.10	17.11	15.68
Wyoming	......	16.40	11.55	12.15	12.35	16.64	15.19	17.50	16.35	12.60
Colorado	14.99	14.75	11.08	6.86	11.64	13.16	10.67	16.80	14.73	13.51
New Mexico	11.59	9.43	11.04	12.66	15.84	14.89	13.86	18.00	14.76	8.42
Arizona	10.80	10.88	12.17	11.38	17.00	13.33	18.40	13.32	29.16	9.79
Utah	13.65	13.13	10.73	8.28	11.66	9.86	18.02	14.28	15.12	10.97
Nevada	11.61	15.92	14.40	10.73	15.00	10.63	20.70	21.87	27.55	13.68
Idaho	12.87	16.80	13.20	11.58	9.48	8.37	15.93	15.40	15.81	12.10
Washington	14.06	13.12	9.98	9.74	6.47	6.35	13.32	15.98	13.07	11.58
Oregon	10.88	16.72	10.05	9.63	7.61	9.40	12.24	12.24	12.71	10.18
California	9.12	12.35	8.84	7.05	6.44	7.80	12.12	8.30	6.55	8.74
Oklahoma	......	......	......	......	5.76	5.47	8.84	14.44	7.75	7.05
General average	9.28	12.86	8.35	6.16	6.48	6.99	8.97	10.86	8.92	7.17

OATS.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Maine	$16.13	$15.57	$14.49	$16.34	$14.74	$13.63	$12.40	$9.92	$12.24	$13.30
New Hampshire	15.40	16.10	14.96	14.71	15.24	12.92	13.30	13.30	12.54	13.65
Vermont	13.10	15.38	15.26	15.29	16.78	14.37	12.56	10.56	13.30	13.69
Massachusetts	14.13	15.51	14.59	14.41	13.72	12.24	12.60	10.56	11.84	12.54
Rhode Island	12.64	15.74	14.46	12.13	14.10	12.64	9.30	10.88	9.99	9.62
Connecticut	10.60	13.50	11.38	10.00	11.09	9.89	8.99	9.86	10.15	10.36
New York	8.90	11.97	10.92	7.20	8.62	8.88	8.58	8.37	8.53	10.23
New Jersey	8.65	11.20	10.54	8.37	10.79	10.29	9.52	7.50	6.08	7.92
Pennsylvania	8.26	10.06	10.08	9.38	8.47	8.56	7.43	7.61	6.99	9.57
Delaware	5.85	7.92	7.33	9.65	6.65	5.54	6.09	5.06	6.60	5.00
Maryland	5.28	7.22	7.22	7.42	8.35	7.07	5.52	6.24	5.65	6.90
Virginia	4.41	4.39	4.37	6.13	4.44	5.31	4.81	3.48	4.67	4.62
North Carolina	4.69	4.85	4.37	6.20	4.80	5.74	4.20	4.81	5.29	4.92
South Carolina	6.36	6.47	5.46	6.25	6.36	7.45	5.28	6.98	7.74	5.64
Georgia	5.82	7.02	5.56	6.92	6.83	6.67	4.92	5.88	7.97	4.32
Florida	6.53	7.07	5.39	6.49	7.20	6.63	6.36	4.77	8.32	4.50
Alabama	7.44	7.68	5.20	7.24	6.73	6.26	5.74	5.59	6.89	4.30
Mississippi	7.92	6.67	5.30	7.28	6.11	6.12	5.72	6.16	7.77	5.00
Louisiana	8.05	6.40	6.10	7.04	10.48	5.40	3.40	6.84	6.88	7.20
Texas	9.52	11.52	9.31	10.54	12.75	5.38	6.80	6.75	8.32	7.50
Arkansas	7.16	6.93	6.28	7.53	7.40	8.13	4.96	5.61	6.61	6.46
Tennessee	4.28	3.88	5.13	5.70	5.11	6.08	4.29	2.80	5.24	4.48
West Virginia	4.77	6.92	7.18	8.93	7.21	7.49	6.72	6.00	5.85	8.05
Kentucky	3.82	6.84	6.77	7.55	7.56	6.81	5.04	4.86	6.05	5.76
Ohio	7.56	10.33	9.20	8.58	9.39	6.97	5.27	6.40	7.42	9.00
Michigan	11.70	10.40	10.05	8.32	8.87	5.50	5.70	5.98	8.86	9.52
Indiana	7.17	7.52	9.01	7.70	9.69	4.58	4.64	5.74	6.72	7.36
Illinois	8.61	10.14	8.15	7.34	10.47	4.15	4.20	5.76	6.67	8.36
Wisconsin	10.40	9.32	8.76	7.45	9.87	6.08	5.95	6.46	8.66	8.28
Minnesota	9.47	9.85	7.64	6.45	8.43	5.59	4.95	4.94	7.62	7.04
Iowa	9.80	9.54	6.60	5.70	7.17	6.47	3.30	4.80	8.16	6.27
Missouri	6.79	6.90	6.00	5.85	6.76	4.99	3.06	4.18	3.91	6.09
Kansas	9.12	8.10	7.41	5.00	5.55	3.04	2.08	4.32	3.96	6.38
Nebraska	8.31	8.16	6.14	3.30	4.54	3.33	2.09	4.65	6.42	6.60
South Dakota	6.72	8.08	6.05	5.37	2.65	4.35	3.58	3.96	5.63	5.98
North Dakota		8.71	7.42	6.13	7.51	5.14	3.96	5.98	7.98	8.10
Montana	18.29	18.48	11.52	12.58	12.43	15.75	14.57	13.86	14.21	14.82
Wyoming	......	......	10.87	9.60	14.59	15.99	16.96	12.25	12.48	12.00
Colorado	12.40	12.39	9.76	9.88	6.21	9.60	8.40	10.88	14.68	11.34
New Mexico	13.68	12.10	11.37	14.89	17.50	17.96	10.80	14.56	15.91	10.56
Utah	15.13	13.65	10.60	9.21	11.22	10.14	14.82	11.55	15.09	13.60
Idaho	17.40	17.50	10.73	13.57	12.32	10.21	12.60	11.62	15.70	12.92
Washington	15.74	15.58	12.07	13.90	11.32	11.28	14.40	16.80	16.76	14.06
Oregon	15.00	12.92	9.81	10.55	7.48	7.78	6.93	11.20	10.80	12.30
California	15.40	17.10	11.72	9.69	15.66	10.96	13.64	8.82	16.50	14.57
General average	8.40	9.08	7.73	6.88	7.95	5.87	4.81	5.75	7.23	7.52

Average value per acre of principal farm crops, 1890–1899—Continued.

BARLEY.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Maine	$15.29	$19.08	$15.16	$17.49	$17.23	$16.85	$13.16	$13.75	$15.12	$17.11
New Hampshire	16.29	19.46	17.39	17.71	15.37	14.34	15.53	13.50	13.63	16.25
Vermont	15.75	19.66	17.16	16.50	16.74	15.60	13.53	13.11	14.10	16.12
Massachusetts	16.94	20.03	16.87	22.77	13.67	14.63	17.40	22.77	16.17	20.40
Rhode Island	16.49	21.84	17.63	21.92	21.60	17.63	17.40	15.12	17.08	20.30
New York	13.03	15.15	16.65	12.18	9.80	18 55	9.05	10.50	12.10	12.00
Pennsylvania	14.70	14.40	12.37	9.50	7.97	8.28	6.88	9.55	8.54	10.29
Texas	9.72	11.86	10.73	8.99	8.41	11.66	6.00	10.75	10.00	11.88
Tennessee	13.61	6.86	12.87	8.31	7.73	11.55	6.30	10.62	10.08	7.04
Kentucky	12.42	13.23	8.47	8.67	13.49	12.65	5.92	8.00	6.40	9.03
Ohio	13.65	15.42	13.39	10.67	13.68	11.56	7.68	11.69	12.63	12.60
Michigan	14.05	14.70	14.04	8.04	10.30	7.78	9.37	8.60	11.09	11.52
Indiana	10.72	13.87	14.56	8.95	9.32	6.00	6.70	8.36	10.30	11.25
Illinois	12.18	14.30	8.77	9.28	11.28	9.00	7.35	9.50	10.65	13.63
Wisconsin	13.17	14.57	12.75	10.32	12.87	9.96	7.40	8.96	11.64	12.00
Minnesota	12.37	11.74	12.31	7.96	9.63	8.64	5.44	6.12	9.37	7.75
Iowa	11.75	11.47	8.44	7.46	6.51	6.44	5.52	5.76	8.84	8.06
Missouri	11.40	14.71	12.22	8.00	7.14	7.34	4.38	7.60	7.20	7.56
Kansas	10.26	10.60	8.75	3.81	4.31	3.31	1.01	4.38	7.56	4.59
Nebraska	9.86	10.66	7.33	3.72	2.45	6.82	3.78	5.28	6.78	7.80
South Dakota	10.14	11.68	8.16	5.08	4.72	3.71	5.42	4.40	6.21	6.67
North Dakota		12.60	8.02	4.71	7.24	6.08	3.38	6.07	7.66	7.92
Montana	17.76	19.50	21.45	15.05	9.00	14.75	13.75	19.00	20.52	17.85
Colorado	18.62	14.84	12.96	14.15	16.04	18.78	9.20	14.28	14.03	15.40
New Mexico	12.96	15.40	12.74	12.53	18.90	19.04	12.35	17.88	18.59	19.52
Utah	17.40	16.02	10.56	16.92	15.18	11.70	11.38	13.95	17.39	17.16
Idaho	15.75	19.72	8.58	15.90	15.32	10.29	3.37	14.70	16.80	16.10
Washington	17.00	18.90	11.39	15.64	10.78	14.17	10.40	19.35	17.91	15.40
Oregon	17.50	11.52	10.72	10.44	12.74	8.84	9.81	14.63	14.26	14.00
California	16.72	14.46	11.28	9.45	6.84	8.12	10.37	12.42	6.82	13.00
General average	13.44	13.56	11.18	8.92	8.56	8.88	7.62	9.25	8.93	10.28

RYE.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Maine	$10.03	$15.52	$11.34	$12.96	$13.37	$16.32	$12.06	$11.07	$15.12	$12.60
New Hampshire	10.50	15.39	11.62	11.78	11.40	12.16	14.11	15.12	13.12	12.15
Vermont	10.32	14.49	10.44	10.22	9.56	9.12	12.09	9.60	11.08	10.54
Massachusetts	10.94	14.69	10.94	12.15	14.02	13.33	15.40	11.90	10.52	12.64
Connecticut	9.76	13.44	10.44	10.49	8.39	10.65	8.78	11.21	10 80	11.52
New York	8.98	13.20	8.26	9.39	8.32	8.69	6.29	8.88	8.75	8.96
New Jersey	8.48	11.73	8.37	9.38	8.14	6.94	6.49	8.50	7.75	8.25
Pennsylvania	8.54	11.84	7.81	8.38	7.78	7.55	7.52	8.17	7.57	7.65
Maryland	7.21	10.74	7.01	6.68	6.35	6.32	4.42	7.82	7.83	7.98
Virginia	4.42	6.72	5.54	5.21	4.75	5.72	4.80	5.50	5 15	4.77
North Carolina	4.62	5.95	5.52	5.39	6.30	4.93	5.32	5.28	5.82	5.25
South Carolina	4.59	6.42	5.88	5.94	4.51	10.70	4.18	5.68	8.67	5.45
Georgia	4.41	8.74	6.00	6.91	6.31	6.12	7.17	6.81	7.84	6.72
Alabama	6.48	8.40	6.50	11.27	12.64	8.57	7.04	11.33	11.65	8.32
Texas	4.40	8.96	7.84	6.32	8.48	4.13	4.69	8.64	8.52	8.20
Arkansas	4.09	8.18	6.72	4.35	6.84	7.20	7.09	9.46	7.41	8.14
Tennessee	4.73	7.40	5.65	5.60	4.48	4.46	5.40	5.80	5.56	6.03
West Virginia	6.56	7.98	6.37	5.33	4.56	9.82	5.94	5.87	5 82	6 20
Kentucky	6.65	8.55	7.01	7.66	7.20	7.39	5.94	6.89	7.15	7 00
Ohio	7.37	13.18	7.06	7.14	8.23	6.66	3.74	7 92	7 83	8.80
Michigan	8.04	11.70	7.26	5.63	6.07	5.44	2.94	6.30	6.58	7.28
Indiana	8.22	13.42	6.50	6.48	8.11	5.12	3.82	5.46	6.67	6.24
Illinois	7.49	13.48	6.15	5.70	8 00	6.08	5.20	6.82	6.51	7 05
Wisconsin	7.00	11.39	6.58	6 24	6.88	5 64	4.82	6 56	6.58	7.20
Minnesota	7.42	11.70	7.52	6.27	7.53	5.91	4.68	6 36	7.79	7.56
Iowa	6.85	11.39	6.47	5.99	7.77	6.39	5.08	5.76	7.60	7.20
Missouri	7.37	9.86	6.25	5.76	7.24	4.76	5.73	5 28	6 16	6.50
Kansas	7.15	9.15	6.00	2.66	2.67	2.24	2.45	5.60	5.77	4.62
Nebraska	6.86	9.42	5.65	3 54	2.93	2.79	3.72	5.44	6.39	6.08
South Dakota	5.59	9.18	4.62	3.92	2.07	2.10	3.13	5.78	5.64	5.55
North Dakota		11.38	5.19	3.94	5.55	5.75	2.64	5.22	5 40	5.55
Colorado	9.43	12.77	7.59	10.50	10.30	6.96	11.57	7.80	9.00	6.72
Utah	8.51	10.75	7.26	5.59	10.83	6.93	8 00	7.20	8.97	8.16
Washington	9.66	11.73	9.35	10 42	8.06	20.03	7.50	12.09	10.44	9.60
Oregon	9.72	11.04	7.20	7.66	8.04	6.05	7 62	8.85	10.37	7.70
California	9.80	14.85	7.70	10.50	7.92	6.73	8.70	7.93	6.30	11.70
General average	7.58	11.30	6.98	6.68	6.89	6.33	5.44	7.18	7.23	7.36

Average value per acre of principal farm crops, 1890-1899—Continued.

BUCKWHEAT.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Maine	\$11.00	\$13.42	\$10.83	\$15.66	\$21.92	\$17.76	\$16.07	\$15.40	\$10.34	\$9.68
New Hampshire	11.16	14.40	12.25	8.58	12.20	14.05	17.20	14.85	9.40	10.00
Vermont	11.00	12.37	9.60	15.48	12.77	12.77	12.56	11.04	9.84	11.96
Massachusetts	11.38	11.55	8.97	20.63	12.85	8.85	9.70	12.54	12.20	14.00
Connecticut	8.82	12.32	9.00	11.38	10.99	8.62	7.24	9.69	10.64	11.97
New York	8.99	9.80	7.35	8.64	8.37	9.42	6.96	8.80	7.56	7.67
New Jersey	8.40	9.51	7.12	9.50	9.36	9.35	8.07	7.84	11.34	11.76
Pennsylvania	7.43	7.75	7.69	8.32	9.54	8.76	6.57	8.82	7.57	10.80
Delaware	8.41	11.47	8.46	11.00	10.60	5.00	6.00	6.84	6.60	8.82
Maryland	7.08	8.75	8.12	6.84	11.20	6.10	11.12	9.69	6.47	7.28
Virginia	6.18	8.12	5.06	7.31	7.94	5.45	8.46	7.00	7.79	7.56
North Carolina	6.93	6.44	3.96	5.63	8.79	5.28	12.00	5.39	9.36	8.33
Tennessee	5.77	8.86	4.65	6.80	7.30	5.40	14.88	10.26	9.36	6.84
West Virginia	8.16	8.10	10.60	7.82	14.01	10.72	9.75	9.31	10.05	9.52
Ohio	7.80	10.08	7.43	7.20	9.83	8.03	8.08	9.00	10.20	9.28
Michigan	9.08	7.10	6.37	7.37	6.60	7.40	5.81	6.46	5.96	6.05
Indiana	9.75	8.32	6.67	3.86	8.29	8.29	12.24	6.86	9.38	9.44
Illinois	8.99	8.96	6.78	6.61	9.01	5.85	6.21	7.41	7.28	8.70
Wisconsin	7.58	5.03	6.08	9.01	4.76	8.23	5.13	6.84	6.20	9.45
Minnesota	6.66	7.00	6.21	8.06	5.43	7.80	4.35	7.65	7.35	8.84
Iowa	8.95	8.19	6.42	8.05	10.20	6.75	7.45	8.33	7.69	9.28
Missouri	8.58	9.37	7.35	7.37	5.52	5.92	15.26	9.00	9.48	8.54
Nebraska	8.40	6.96	4.10	7.64	2.52	4.36	10.65	7.14	7.81	9.92
Oregon	11.20	12.59	8.40	10.60	20.90	7.75	14.28	9.90	8.12	12.58
General average	8.45	8.56	7.31	8.67	8.92	9.09	7.32	8.80	7.77	9.23

POTATOES.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Maine	\$67.45	\$51.25	\$63.14	\$64.80	\$64.68	\$55.42	\$62.70	\$52.51	\$59.80	\$58.38
New Hampshire	64.55	49.50	68.00	74.97	56.40	42.88	50.76	45.90	44.10	58.42
Vermont	59.85	45.00	36.72	53.28	54.56	40.04	37.12	49.00	44.10	47.52
Massachusetts	73.08	64.80	68.89	90.44	68.25	63.84	61.56	55.80	61.11	76.38
Rhode Island	76.50	72.00	80.75	85.32	95.76	62.10	56.70	106.70	78.72	71.00
Connecticut	68.00	50.60	62.32	65.25	53.72	52.48	48.76	48.60	55.00	59.80
New York	48.36	32.19	40.95	38.50	36.96	28.06	27.59	41.54	30.66	35.20
New Jersey	62.32	48.02	53.25	54.75	37.20	31.96	33.84	53.04	45.75	42.33
Pennsylvania	52.36	36.12	43.20	45.60	36.48	31.08	29.43	41.58	31.32	36.55
Delaware	52.50	34.20	26.46	32.50	25.00	22.04	27.30	39.00	33.81	35.52
Maryland	49.70	37.44	40.80	33.32	27.56	26.10	27.00	50.32	30.74	32.64
Virginia	45.56	35.72	34.80	47.88	33.04	27.74	31.62	42.70	37.40	36.96
North Carolina	47.45	51.00	33.55	58.20	37.20	43.45	33.97	42.24	41.54	37.62
South Carolina	56.70	56.58	59.50	63.91	45.43	65.70	34.32	68.25	65.00	58.24
Georgia	68.40	59.20	56.00	68.08	42.12	41.18	41.25	52.00	40.50	38.18
Florida	72.75	66.60	48.75	101.79	67.50	55.00	63.00	90.00	76.80	85.56
Alabama	62.31	52.26	49.40	73.04	37.84	56.70	48.00	51.70	61.42	48.72
Mississippi	59.78	48.60	50.92	68.04	59.04	37.12	43.40	48.38	53.28	62.22
Louisiana	57.96	59.86	50.05	55.61	37.35	64.08	41.80	54.40	58.50	48.60
Texas	69.30	65.55	51.85	54.59	79.20	69.42	40.56	57.00	67.08	58.24
Arkansas	52.80	48.01	47.60	56.32	43.46	35.70	31.27	46.20	40.70	44.73
Tennessee	52.70	38.50	32.16	33.32	26.95	25.60	24.80	29.30	29.64	28.60
West Virginia	47.56	36.96	34.80	47.20	29.64	28.98	28.83	35.40	33.48	37.44
Kentucky	27.72	35.10	30.16	38.08	30.24	33.54	28.65	31.49	29.44	31.11
Ohio	39.10	31.30	38.40	38.86	32.76	20.16	23.14	26.04	25.01	30.53
Michigan	37.12	23.04	32.86	33.75	26.66	16.16	16.72	30.96	21.33	21.12
Indiana	34.04	34.41	40.32	37.23	31.86	20.46	21.25	19.32	29.11	32.68
Illinois	28.50	36.80	41.60	39.22	32.00	23.10	25.22	23.56	32.20	29.76
Wisconsin	37.80	25.48	35.10	37.73	23.85	18.19	14.82	37.62	23.52	26.78
Minnesota	40.89	24.00	33.60	30.36	19.89	22.12	17.64	32.86	21.25	24.00
Iowa	33.60	21.78	38.25	37.70	29.67	20.14	20.68	28.50	24.00	28.60
Missouri	31.20	33.50	39.27	44.46	35.88	27.25	24.18	26.46	29.04	33.20
Kansas	27.44	30.80	41.36	34.76	27.88	30.24	18.63	26.40	35.70	42.75
Nebraska	26.73	27.16	36.00	34.76	16.94	20.10	22.50	31.74	24.65	23.50
South Dakota	20.60	25.48	35.20	31.86	17.02	17.16	19.20	30.08	20.16	21.66
North Dakota		21.00	30.00	33.81	38.64	21.76	21.42	32.67	29.58	27.81
Montana	58.40	49.20	60.00	95.22	53.28	25.44	54.40	62.40	57.20	74.73
Wyoming	58.40	43.00	70.00	87.10	90.00	56.00	71.81	82.50	78.00	76.25
Colorado	54.75	32.20	60.59	50.76	46.75	31.35	41.36	54.32	41.58	46.20
New Mexico	76.00	53.55	28.00	46.90	60.00	50.40	48.96	70.20	45.24	32.32
Utah	63.75	36.25	42.48	29.04	40.50	58.48	49.60	44.40	41.85	66.00
Nevada	66.50	49.00	58.00	52.80	56.35	57.00	72.20	98.55	139.50	91.80
Idaho	63.75	46.00	52.92	85.68	94.34	42.00	48.60	44.80	64.80	75.64
Washington	69.00	47.50	50.00	46.80	35.00	41.72	50.00	45.36	42.14	72.00
Oregon	65.00	44.00	39.20	59.69	40.32	24.96	33.93	64.00	40.42	56.35
California	64.60	51.31	44.25	48.00	25.48	36.00	42.40	51.45	52.25	74.97
General average	42.32	33.53	40.65	41.71	33.43	26.73	26.08	35.37	31.11	34.60

Average value per acre of principal farm crops, 1890–1899—Continued.

HAY.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Maine	$9.25	$8.84	$11.52	$11.16	$9.12	$9.87	$10.25	$10.73	$9.12	$9.09
New Hampshire	10.24	10.12	11.88	16.54	9.97	11.88	12.38	13.23	11.56	10.46
Vermont	9.40	14.40	9.50	11.80	11.93	13.11	12.85	12.03	9.21	10.55
Massachusetts	13.50	17.60	18.26	19.93	19.53	19.42	20.99	19.46	17.18	17.52
Rhode Island	15.68	13.81	15.66	16.27	12.25	15.70	18.26	16.67	14.93	15.35
Connecticut	16.20	14.17	16.50	17.32	13.54	13.68	15.74	15.60	14.61	13.63
New York	9.69	12.10	12.10	14.05	11.30	10.00	9.75	11.14	8.05	10.87
New Jersey	13.39	15.12	15.25	17.26	16.34	15.29	16.50	18.81	13.63	12.74
Pennsylvania	9.38	11.50	13.53	14.83	13.35	12.42	12.88	12.81	11.46	13.80
Delaware	12.00	13.20	12.33	12.75	19.50	14.96	14.30	13.50	11.66	12.12
Maryland	12.30	12.49	11.52	14.82	11.46	14.44	10.31	14.17	11.16	13.73
Virginia	13.59	12.43	10.92	14.53	8.56	12.92	11.03	11.07	11.22	11.27
North Carolina	16.08	12.10	12.66	18.89	15.85	16.53	13.55	12.19	15.81	15.15
South Carolina	17.81	14.01	13.56	15.18	16.45	7.62	15.06	11.50	15.20	12.56
Georgia	19.24	15.79	15.93	15.92	14.36	17.44	15.25	17.55	20.56	19.07
Florida	19.84	17.70	16.38	39.50	19.99	20.24	18.20	14.25	22.56	22.41
Alabama	16.87	16.09	14.04	17.08	25.49	15.93	13.72	13.86	17.57	18.92
Mississippi	14.82	14.59	13.38	15.86	17.79	18.91	12.77	14.06	15.96	13.32
Louisiana	13.26	15.05	13.72	14.58	28.85	19.47	16.63	16.62	19.74	18.92
Texas	9.50	11.46	8.99	9.98	10.13	9.52	7.20	10.15	8.77	10.15
Arkansas	11.33	13.74	10.05	10.96	11.66	11.12	8.90	11.25	10.39	12.80
Tennessee	11.50	13.56	11.44	14.96	13.30	15.05	13.54	15.59	14.25	14.74
West Virginia	9.77	10.82	10.50	14.02	10.87	9.04	11.94	11.95	12.94	12.19
Kentucky	11.25	11.98	10.92	13.51	13.19	14.77	11.35	11.70	13.19	13.42
Ohio	9.75	9.84	10.55	13.37	10.74	7.40	9.99	9.00	7.99	11.63
Michigan	10.00	12.65	10.08	13.37	10.85	7.59	9.84	11.55	9.72	10.37
Indiana	10.40	9.24	9.36	12.46	9.63	7.34	9.33	8.44	8.12	10.45
Illinois	9.88	9.65	9.41	10.72	9.50	6.77	8.82	7.93	9.20	10.00
Wisconsin	8.31	10.98	9.18	10.94	10.42	8.47	8.25	8.44	8.62	10.07
Minnesota	6.75	6.61	5.75	7.40	5.41	6.66	6.41	7.06	6.66	7.40
Iowa	8.10	6.60	6.56	9.73	5.39	6.97	6.94	6.37	7.09	7.10
Missouri	8.64	7.13	7.76	8.73	6.65	7.96	6.94	7.07	9.28	8.56
Kansas	4.14	4.71	4.84	6.14	4.04	4.04	3.83	4.42	4.74	5.49
Nebraska	4.25	3.80	5.12	6.09	4.20	3.52	4.05	4.80	5.28	6.14
South Dakota	3.87	5.08	4.25	5.21	4.02	2.60	3.99	3.69	4.14	4.43
North Dakota		4.60	5.33	4.80	4.61	4.94	5.59	5.20	4.87	5.21
Montana	12.60	9.77	9.85	9.94	8.60	10.72	9.47	11.63	9.86	10.93
Wyoming	9.29	8.37	7.26	10.80	16.10	7.02	11.07	9.90	11.40	9.70
Colorado	12.33	15.04	13.00	8.31	17.12	14.21	13.68	12.38	11.88	15.43
New Mexico	10.17	10.45	13.50	17.68	21.62	20.88	17.10	24.50	27.56	18.02
Arizona	9.00	9.90	13.65	14.44	21.84	16.65	28.00	15.00	42.00	27.22
Utah	11.04	7.70	8.83	8.89	14.01	13.49	13.50	14.01	14.62	17.75
Nevada	11.70	6.00	12.25	26.60	29.29	20.32	12.29	12.50	18.20	14.31
Idaho	13.20	8.00	11.10	13.48	10.98	16.06	12.25	12.08	18.37	15.75
Washington	16.80	15.22	12.60	14.49	15.13	12.49	13.83	20.25	13.30	17.98
Oregon	15.00	10.40	12.93	15.23	11.72	10.89	13.07	14.73	13.78	13.49
California	14.70	15.40	13.14	13.30	18.34	11.72	10.48	14.40	22.80	13.04
General average	9.34	9.68	9.64	11.51	9.70	8.89	8.97	9.46	9.30	9.97

COTTON.

States and Territories.	1890–91.	1891–92.	1892–93.	1893–94.	1894–95.	1895–96.	1896–97.	1897–98.	1898–99.
Virginia					$5.94	$7.31	$8.07	$7.39	$7.31
North Carolina				$12.20	10.00	15.52	14.45	14.66	12.93
South Carolina				12.24	10.44	17.26	15.97	13.85	11.06
Georgia				11.97	9.10	14.25	12.71	10.82	10.22
Florida				12.17	6.67	8.28	7.92	8.67	9.84
Alabama				12.24	8.97	11.47	10.65	11.81	10.31
Mississippi				12.92	11.07	16.69	14.47	15.89	11.60
Louisiana				17.50	15.41	18.42	15.40	18.37	15.11
Texas				16.59	12.58	13.40	11.00	12.05	13.82
Arkansas				12.36	11.17	17.98	12.71	16.85	13.40
Tennessee				11.13	7.61	9.92	8.62	7.98	9.77
Missouri						10.13	9.96	9.33	11.60
Oklahoma						22.14	15.92	15.55	14.40
Indian Territory						13.22	21.16	19.94	18.96
General average				13.41	10.94	14.53	12.54	13.14	12.23

Prices of principal agricultural products on the farm, December 1, 1890–1899.

[From Division of Statistics.]

CORN (PER BUSHEL).

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.
Maine	74	80	67	62	72	54	47	47	48	50
New Hampshire	72	77	65	57	76	51	45	45	46	49
Vermont	72	76	64	61	69	48	38	43	44	47
Massachusetts	70	78	62	62	61	52	46	47	49	51
Rhode Island	72	79	63	69	75	56	49	54	64	53
Connecticut	70	76	62	64	68	51	42	49	52	50
New York	65	66	60	55	61	45	38	40	43	45
New Jersey	62	65	58	52	54	42	36	38	40	40
Pennsylvania	60	57	57	49	55	39	33	34	40	41
Delaware	50	55	44	40	45	34	25	30	31	34
Maryland	50	53	45	44	50	37	32	30	35	36
Virginia	55	50	53	46	47	37	32	38	35	38
North Carolina	55	58	54	50	47	38	37	43	43	47
South Carolina	70	70	57	60	65	46	46	49	46	50
Georgia	69	69	56	56	58	41	43	48	48	50
Florida	75	80	60	68	71	47	53	55	50	53
Alabama	68	63	52	59	53	37	45	46	41	47
Mississippi	70	58	51	55	49	37	44	45	39	46
Louisiana	70	60	50	57	62	40	45	45	41	44
Texas	72	55	45	54	56	31	41	41	34	36
Arkansas	65	46	47	45	47	32	37	40	29	38
Tennessee	52	43	43	39	39	27	28	36	29	39
West Virginia	60	52	56	55	57	40	34	40	37	45
Kentucky	49	40	40	43	44	27	25	35	27	37
Ohio	51	41	42	40	43	27	21	25	27	30
Michigan	55	48	46	45	50	32	24	27	34	36
Indiana	47	38	40	36	37	23	19	21	25	27
Illinois	43	37	37	31	39	22	18	21	25	26
Wisconsin	45	44	38	35	45	30	22	25	28	30
Minnesota	42	39	37	34	43	20	19	24	24	24
Iowa	41	30	32	27	45	18	14	17	23	23
Missouri	44	38	36	30	40	20	20	24	27	30
Kansas	51	34	31	31	43	19	18	22	26	25
Nebraska	48	26	28	27	50	18	13	17	22	23
South Dakota	50	35	33	25	46	23	18	21	23	26
North Dakota		40	40	38	44	24	25	32	36	33
Montana	70	------	70	70	82	75	60	65	66	52
Wyoming	65	------	61	63	65	57	78	50	55	43
Colorado	63	53	40	51	61	41	36	38	40	43
New Mexico	73	72	72	71	75	56	55	58	56	58
Utah	68	60	58	58	58	49	51	55	60	59
Washington	50	------	60	62	69	40	57	55	42	55
Oregon	66	71	56	47	56	55	56	53	60	64
California	65	71	55	50	57	53	53	56	62	60
Oklahoma	------	------	------	------	------	------	------	------	------	20
General average	50.63	40.60	39.43	36.53	45.74	25.33	21.50	26.33	28.69	30.23

WHEAT (PER BUSHEL).

Maine	$1.15	$1.10	$1.02	$1.02	$0.79	$0.82	$0.84	$1.06	$0.89	$0.91
New Hampshire	1.15	1.15	1.00	.85	.80	.76	1.00	1.10	.92	.95
Vermont	1.11	1.14	.96	.85	.67	.69	.93	1.04	.90	.85
Connecticut	1.10	1.06	.87	------	------	.68	------	1.00	.88	.95
New York	1.00	1.00	.85	.76	.62	.68	.88	.90	.72	.80
New Jersey	1.00	1.04	.83	.70	.61	.71	.89	.93	.73	.75
Pennsylvania	.99	1.00	.81	.65	.56	.65	.83	.91	.68	.66
Delaware	.96	1.00	.75	.60	.55	.64	.87	.94	.69	.68
Maryland	.92	1.00	.74	.76	.54	.64	.88	.93	.70	.68
Virginia	.96	1.00	.76	.63	.56	.65	.80	.92	.66	.69
North Carolina	1.00	1.02	.89	.72	.65	.72	.83	.94	.78	.82
South Carolina	1.05	1.10	.93	.98	.87	.88	.89	1.18	.94	.99
Georgia	1.10	1.10	.90	.90	.76	.82	.89	1.03	.98	.98
Alabama	1.09	1.10	.93	.88	.78	.80	.85	1.01	.90	.89
Mississippi	1.10	1.00	.90	.85	.75	.61	.82	.99	.83	.78
Texas	.95	.87	.75	.58	.54	.66	.75	.89	.68	.68
Arkansas	.98	.90	.80	.65	.55	.59	.71	.84	.58	.64
Tennessee	.97	.93	.68	.57	.51	.62	.74	.95	.67	.78
West Virginia	.95	.96	.75	.72	.60	.69	.78	.89	.71	.71
Kentucky	.92	.90	.67	.57	.50	.61	.76	.89	.62	.66
Ohio	.91	.92	.68	.57	.49	.60	.78	.88	.66	.64
Michigan	.90	.91	.67	.57	.52	.60	.84	.87	.64	.65
Indiana	.88	.86	.64	.53	.46	.57	.80	.89	.63	.64
Illinois	.87	.85	.63	.51	.45	.53	.74	.89	.60	.63
Wisconsin	.83	.84	.62	.54	.51	.51	.70	.84	.59	.61

Prices of principal agricultural products on the farm, December 1, 1890–1899—C't'd.

WHEAT (PER BUSHEL)—Continued.

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Minnesota	$0.81	$0.78	$0.61	$0.51	$0.49	$0.44	$0.68	$0.77	$0.54	$0.55
Iowa	.80	.81	.60	.49	.50	.46	.62	.75	.52	.55
Missouri	.83	.80	.58	.48	.43	.51	.70	.85	.59	.63
Kansas	.77	.73	.52	.42	.44	.45	.63	.74	.50	.53
Nebraska	.76	.73	.50	.40	.49	.40	.58	.69	.47	.49
South Dakota	.70	.72	.51	.44	.46	.38	.62	.69	.50	.50
North Dakota		.70	.52	.43	.43	.38	.64	.74	.51	.51
Montana	.80	.84	.69	.60	.54	.73	.66	.68	.58	.61
Wyoming	.82	.82	.66	.65	.63	.64	.62	.70	.69	.67
Colorado	.81	.73	.58	.52	.65	.56	.61	.70	.56	.57
New Mexico	.95	.82	.80	.75	.88	.73	.66	.75	.62	.61
Arizona	.90	.75	.78	.65	1.00	.65	.80	.74	.92	.64
Utah	.78	.75	.62	.60	.53	.44	.68	.68	.54	.53
Nevada	.86	.87	.75	.73	.75	.49	.69	.90	.95	.76
Idaho	.78	.84	.60	.60	.46	.47	.65	.70	.51	.50
Washington	.76	.75	.58	.48	.39	.41	.74	.68	.54	.51
Oregon	.75	.88	.64	.55	.43	.47	.72	.72	.62	.53
California	.76	.95	.68	.53	.57	.60	.83	.83	.72	.62
Oklahoma	------	------	------	------	.51	.48	.68	.76	.52	.53
General average	.838	.839	.624	.538	.491	.509	.726	.808	.582	.584

OATS (PER BUSHEL).

	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Maine	57	45	45	45	44	34	31	32	34	38
New Hampshire	56	46	44	43	49	35	35	38	38	39
Vermont	50	41	43	42	51	33	31	32	35	37
Massachusetts	55	47	48	42	43	34	35	33	37	38
Rhode Island	54	47	49	43	47	39	31	34	37	37
Connecticut	53	45	45	40	43	31	31	34	36	37
New York	50	38	39	30	39	28	26	27	31	33
New Jersey	50	40	41	35	38	29	28	30	31	33
Pennsylvania	48	37	40	35	38	27	24	27	30	29
Delaware	45	39	38	38	35	29	21	23	30	25
Maryland	44	38	38	35	39	27	23	26	29	32
Virginia	45	41	39	35	37	30	26	29	29	33
North Carolina	51	51	45	44	44	38	35	37	37	41
South Carolina	60	61	52	53	53	49	48	45	45	47
Georgia	60	60	52	52	51	46	41	42	48	48
Florida	61	62	55	55	61	65	53	53	54	50
Alabama	62	60	51	51	51	42	41	43	41	43
Mississippi	60	58	50	47	47	39	44	44	42	50
Louisiana	61	52	50	44	47	36	34	38	38	40
Texas	55	47	38	42	39	26	34	27	28	30
Arkansas	53	42	40	39	40	32	31	33	29	34
Tennessee	45	40	38	31	35	27	26	28	28	32
West Virginia	45	40	41	38	39	32	28	30	30	35
Kentucky	45	37	37	34	36	26	24	27	27	32
Ohio	42	33	35	30	31	22	17	20	24	25
Michigan	44	32	35	32	34	23	19	23	27	28
Indiana	41	32	34	28	30	20	16	19	23	23
Illinois	41	28	31	27	29	17	15	18	23	22
Wisconsin	40	28	29	27	30	18	17	19	24	23
Minnesota	37	27	28	26	30	14	15	19	21	22
Iowa	38	26	26	23	28	14	12	16	24	19
Missouri	39	29	30	25	29	18	17	19	23	24
Kansas	38	27	26	27	31	17	16	18	22	22
Nebraska	39	23	23	22	36	14	11	15	20	22
South Dakota	32	25	23	25	35	17	13	18	21	23
North Dakota		26	28	28	29	16	18	26	26	27
Montana	59	48	40	37	31	44	31	33	35	39
Wyoming	56	------	38	40	48	39	53	35	40	40
Colorado	50	38	34	37	46	28	30	32	41	42
New Mexico	57	55	56	51	50	45	40	41	41	44
Utah	55	42	40	33	34	30	39	33	38	40
Idaho	58	50	37	41	32	29	30	32	36	38
Washington	47	41	35	35	31	28	40	35	40	38
Oregon	50	41	37	37	28	27	33	35	40	41
California	56	60	40	38	44	39	44	49	50	47
General average	42.41	31.46	31.66	29.36	32.45	19.85	18.73	21.18	25.50	24.89

Prices of principal agricultural products on the farm, December 1, 1890–1899—C't'd.

BARLEY (PER BUSHEL).

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Maine	76	72	68	67	66	52	43	55	56	59
New Hampshire	81	74	74	70	63	56	53	60	58	65
Vermont	70	72	66	60	60	47	41	46	47	52
Massachusetts	77	75	75	90	63	65	58	66	66	68
Rhode Island	76	78	82	87	72	75	60	54	61	70
New York	78	65	75	60	56	81	39	42	48	50
Pennsylvania	70	64	57	50	48	41	40	39	44	49
Texas	......	78	65	62	55	54	50	43	50	66
Tennessee	......	......	66	55	56	50	45	59	56	64
Kentucky	......	......	38	51	47	38	40	40	40	43
Ohio	70	60	57	47	48	41	38	41	44	45
Michigan	63	60	60	49	50	43	42	40	44	48
Indiana	65	59	52	45	45	40	33	44	44	45
Illinois	60	55	49	40	48	45	31	38	39	47
Wisconsin	58	55	50	43	45	34	27	32	40	40
Minnesota	55	43	42	36	41	24	20	24	33	31
Iowa	52	42	40	33	42	23	21	24	34	31
Missouri	57	57	42	40	51	48	25	40	36	42
Kansas	57	40	35	47	49	23	22	25	27	27
Nebraska	57	37	33	31	43	24	19	24	25	30
South Dakota	52	41	35	33	35	19	19	22	27	29
North Dakota		42	33	31	36	20	21	27	29	33
Montana	74	65	66	50	40	59	55	50	57	51
Colorado	76	56	54	50	58	60	46	51	46	55
New Mexico	......	70	65	58	70	68	65	55	55	61
Utah	75	60	52	45	46	39	42	45	47	52
Idaho	75	68	33	53	47	42	22	42	48	46
Washington	68	60	45	39	32	38	40	43	45	44
Oregon	70	48	46	40	33	40	45	45	49	50
California	75	61	47	42	45	40	48	54	65	50
General average	64.80	54.00	47.20	41.12	44.19	33.66	32.27	37.70	41.34	40.33

RYE (PER BUSHEL).

	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Maine	85	97	84	108	81	85	67	82	84	84
New Hampshire	84	95	83	78	74	76	72	84	75	81
Vermont	80	90	73	73	73	57	65	60	58	62
Massachusetts	81	96	72	75	73	67	70	61	63	79
Connecticut	80	94	73	66	65	63	57	59	60	64
New York	73	83	65	63	54	48	44	48	50	56
New Jersey	75	82	62	70	55	51	47	50	50	55
Pennsylvania	70	80	62	57	56	50	47	43	47	51
Maryland	70	88	62	51	47	49	48	46	54	57
Virginia	67	82	63	56	54	52	48	50	46	53
North Carolina	81	85	85	70	70	64	71	60	64	75
South Carolina	85	107	98	110	96	115	87	86	102	109
Georgia	90	115	100	108	97	85	101	92	98	112
Alabama	90	112	100	115	95	84	88	118	105	104
Texas	80	80	70	68	75	75	67	72	71	82
Arkansas	......	88	82	58	76	72	70	86	65	74
Tennessee	75	85	65	59	59	62	60	58	53	67
West Virginia	69	76	67	65	57	61	56	51	52	62
Kentucky	70	83	62	58	59	56	54	53	55	70
Ohio	63	85	56	47	45	45	39	44	45	55
Michigan	60	78	53	44	46	40	32	42	43	52
Indiana	60	78	52	45	42	42	36	42	43	48
Illinois	59	77	50	41	43	40	34	44	44	47
Wisconsin	56	78	48	43	43	35	33	41	43	48
Minnesota	53	68	44	41	43	28	30	37	38	42
Iowa	50	67	49	41	46	31	29	36	40	40
Missouri	58	73	50	45	47	39	47	44	47	50
Kansas	55	64	40	38	46	38	35	40	37	42
Nebraska	52	60	39	35	48	30	22	32	34	38
South Dakota	47	60	37	37	46	25	27	35	34	37
North Dakota		65	44	32	37	27	22	36	36	37
Colorado	65	62	52	50	66	48	62	52	50	48
Utah	63	64	55	47	57	35	40	60	46	48
Washington	68	82	55	69	56	75	50	62	58	60
Oregon	68	80	60	73	57	54	60	59	72	70
California	70	90	67	60	60	58	60	65	70	78
General average	62.89	77.44	54.18	51.26	50.12	43.97	49.87	44.73	46.28	50.97

Prices of principal agricultural products on the farm, December 1, 1890–1899—C't'd.

BUCKWHEAT (PER BUSHEL).

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Maine	55	61	57	54	58	46	38	44	39	44
New Hampshire	62	67	70	37	61	47	63	55	47	50
Vermont	55	55	48	53	57	37	40	46	46	52
Massachusetts	65	70	78	75	68	59	53	66	61	70
Connecticut	60	77	75	72	67	56	51	57	56	63
New York	58	56	50	60	54	44	37	40	45	59
New Jersey	60	67	57	66	65	50	39	49	54	56
Pennsylvania	55	57	53	59	53	44	38	42	44	54
Delaware	58	75	60	55	50	50	30	36	40	49
Maryland	59	70	65	58	56	56	49	51	53	56
Virginia	65	65	61	55	54	54	47	50	45	54
North Carolina	63	56	55	49	47	44	60	49	48	49
Tennessee	....	....	62	54	57	54	62	57	52	57
West Virginia	68	60	65	68	62	57	50	49	49	56
Ohio	65	65	59	60	66	55	43	50	51	58
Michigan	55	50	49	53	55	43	38	38	42	55
Indiana	65	63	58	56	56	58	51	49	51	59
Illinois	62	64	60	57	77	44	45	57	52	58
Wisconsin	53	53	45	57	56	46	38	38	40	63
Minnesota	52	56	45	53	59	51	41	45	49	52
Iowa	63	60	60	61	75	50	46	49	48	58
Missouri	65	75	65	58	60	58	70	60	60	61
Nebraska	70	58	50	52	68	65	50	51	61	62
Oregon	70	81	75	50	55	59	68	55	58	74
General average	57.37	56.98	51.85	58.36	55.57	45.21	39.19	42.14	44.97	55.74

POTATOES (PER BUSHEL).

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Maine	71	41	77	54	44	34	38	89	46	42
New Hampshire	72	45	85	63	47	32	47	90	49	46
Vermont	63	38	68	48	44	26	29	70	42	36
Massachusetts	84	54	83	76	65	48	57	90	63	57
Rhode Island	85	60	85	79	72	45	54	97	64	50
Connecticut	85	55	76	75	68	41	46	90	55	46
New York	78	37	65	55	48	23	31	67	42	40
New Jersey	82	49	75	75	62	34	36	78	61	51
Pennsylvania	77	43	72	60	57	28	27	66	58	43
Delaware	75	45	63	65	50	38	35	65	69	51
Maryland	71	48	68	68	53	30	30	68	53	51
Virginia	67	47	60	57	56	38	34	70	55	56
North Carolina	65	68	61	60	60	55	43	64	62	66
South Carolina	90	82	85	77	77	73	66	105	100	104
Georgia	95	80	80	92	81	71	75	100	75	83
Florida	97	90	75	117	75	100	84	120	120	124
Alabama	93	78	76	88	88	81	75	94	83	87
Mississippi	98	81	76	84	82	64	62	82	72	102
Louisiana	92	82	77	83	83	72	76	85	75	81
Texas	90	95	85	103	99	78	78	95	86	91
Arkansas	88	64	70	64	53	51	53	84	55	71
Tennessee	85	55	48	49	49	40	40	73	57	65
West Virginia	82	42	58	59	57	42	31	65	54	52
Kentucky	84	45	52	56	56	39	33	67	46	61
Ohio	85	35	64	67	52	32	26	62	41	43
Michigan	64	24	53	45	43	16	19	43	27	32
Indiana	92	37	72	73	54	31	25	62	41	43
Illinois	95	40	80	74	64	30	26	62	46	41
Wisconsin	63	26	54	49	53	17	19	38	24	26
Minnesota	60	24	48	46	51	14	21	31	25	25
Iowa	70	22	75	65	69	19	22	47	30	23
Missouri	80	35	77	57	52	25	31	63	44	49
Kansas	98	35	88	79	68	42	27	55	51	45
Nebraska	99	28	75	79	77	30	25	46	37	25
South Dakota	68	28	55	59	74	26	20	32	28	27
North Dakota		20	40	49	46	17	21	33	34	27
Montana	80	41	69	69	48	48	32	40	55	53
Wyoming	80	43	70	65	60	56	43	55	65	61
Colorado	75	28	61	54	55	33	47	56	54	55
New Mexico	95	63	80	67	89	63	68	78	78	68
Utah	75	25	72	33	30	34	32	30	31	55
Nevada	70	50	58	40	35	38	38	73	90	90
Idaho	....	40	54	56	53	40	30	32	54	61
Washington	60	38	50	39	28	28	40	28	39	50
Oregon	65	40	56	47	36	39	39	40	47	49
California	68	54	59	50	49	48	53	49	55	63
General average	75.77	35.78	66.11	59.37	53.59	26.57	23.62	54.66	41.38	39.04

Prices of principal agricultural products on the farm, December 1, 1890–1899—C'td.

HAY (PER TON).

States and Territories.	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
Maine	$9.25	$9.30	$12.80	$12.13	$9.60	$9.68	$10.25	$9.75	$7.60	$10.10
New Hampshire	9.75	11.00	13.20	15.60	10.50	12.50	12.80	11.50	9.25	11.75
Vermont	8.70	9.00	10.00	10.63	9.94	12.25	10.28	9.25	6.35	9.25
Massachusetts	13.50	16.00	16.60	17.33	15.50	17.50	16.40	13.90	12.10	15.50
Rhode Island	14.00	16.25	17.40	19.60	16.33	17.25	16.60	14.50	12.65	17.25
Connecticut	13.50	15.75	16.50	17.50	15.56	16.10	14.71	13.00	11.15	14.50
New York	7.75	11.00	11.00	11.33	9.66	13.70	12.04	8.25	5.75	10.45
New Jersey	10.30	14.40	14.25	17.43	14.09	12.64	14.35	10.75	9.60	15.35
Pennsylvania	7.50	10.60	12.30	14.40	11.31	12.30	12.15	9.15	7.90	11.50
Delaware	10.00	12.00	12.33	17.00	15.00	12.16	13.00	10.00	8.45	11.65
Maryland	9.84	11.15	11.75	14.25	11.13	11.55	11.85	10.50	9.30	12.15
Virginia	10.70	11.00	11.50	13.09	11.89	11.43	10.21	10.25	8.50	10.25
North Carolina	11.91	11.00	10.55	11.11	10.93	10.14	10.75	9.75	9.30	10.10
South Carolina	13.00	12.18	11.30	9.67	10.75	7.62	11.32	11.50	9.50	10.30
Georgia	14.25	13.50	11.80	12.06	12.38	10.90	11.05	13.00	11.75	13.15
Florida	15.50	15.00	14.00	19.75	16.25	13.23	13.00	14.25	14.10	15.35
Alabama	13.50	12.38	10.80	11.24	9.51	10.21	9.80	10.25	9.25	11.40
Mississippi	11.40	11.22	9.91	9.61	9.67	9.70	9.46	9.50	8.40	9.25
Louisiana	10.20	11.58	9.80	9.00	10.64	9.64	8.75	8.75	9.40	9.70
Texas	9.50	8.75	8.56	9.60	7.62	6.43	7.20	7.25	5.85	7.10
Arkansas	10.30	10.57	8.74	9.37	8.83	9.27	7.54	8.65	6.75	8.65
Tennessee	10.00	11.30	10.40	10.76	11.27	10.83	9.67	10.75	9.50	11.25
West Virginia	8.50	9.17	10.50	12.25	10.66	12.73	9.79	8.85	8.40	9.45
Kentucky	9.00	10.15	9.50	10.16	10.47	10.94	9.46	10.00	9.10	10.40
Ohio	7.50	8.20	9.17	10.05	8.46	12.76	7.93	6.25	5.75	8.95
Michigan	8.00	11.00	8.40	9.16	9.04	13.09	8.48	7.75	7.15	8.50
Indiana	8.60	7.70	7.80	9.16	7.58	12.03	7.18	5.90	5.60	7.80
Illinois	7.60	7.72	7.53	8.86	8.33	10.25	6.39	6.15	5.90	7.75
Wisconsin	6.65	9.80	7.65	7.20	7.96	9.63	6.60	6.25	5.75	6.85
Minnesota	5.00	5.75	4.60	4.57	5.30	5.12	3.79	4.50	3.70	4.35
Iowa	6.75	5.50	5.25	6.16	7.39	6.45	3.99	4.25	4.05	5.30
Missouri	7.20	6.20	6.75	7.04	7.82	6.80	4.85	6.15	5.80	6.25
Kansas	5.18	3.62	4.40	4.69	5.25	3.26	2.70	3.40	3.25	3.50
Nebraska	5.00	3.17	4.27	4.87	7.12	3.56	2.44	3.00	3.30	3.70
South Dakota	4.50	4.20	3.40	3.67	4.28	3.29	3.12	2.95	3.00	3.10
North Dakota		4.00	4.10	3.72	3.87	3.48	3.39	3.25	3.25	3.30
Montana	10.50	8.50	8.95	7.89	7.17	1.40	6.86	7.75	6.80	7.70
Wyoming	......	9.00	6.40	8.00	10.00	6.50	7.14	6.00	5.90	6.60
Colorado	9.00	8.00	6.50	6.98	7.54	5.87	6.22	5.50	5.40	7.35
New Mexico	9.00	9.50	11.25	8.50	11.50	8.00	5.70	7.00	7.35	10.60
Arizona	7.50	......	10.50	8.25	12.00	9.00	8.75	5.00	12.00	10.35
Utah	8.00	5.50	6.31	5.17	5.56	5.27	5.00	4.75	4.50	7.10
Nevada	9.75	5.00	7.00	10.60	7.25	6.75	4.82	5.60	7.00	7.65
Idaho	11.00	6.67	7.40	5.50	4.34	6.25	4.71	5.25	4.90	6.30
Washington	12.00	10.50	9.00	9.17	7.38	6.75	7.09	9.00	7.60	8.90
Oregon	10.00	8.00	8.92	8.10	5.86	6.12	6.60	7.75	7.25	6.85
California	10.50	11.00	8.76	7.87	9.50	7.06	6.35	9.00	14.25	8.00
General average	7.74	8.39	8.49	8.68	8.54	8.35	6.55	6.62	6.00	7.27

COTTON (PER POUND).

	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Virginia	8.7	7.0	8.6	7.1	5.0	7.8	7.1	6.9	5.9	7.0
North Carolina	8.7	7.4	8.6	7.2	4.8	8.2	6.7	7.0	5.9	7.2
South Carolina	8.7	7.4	8.6	7.1	5.0	8.8	6.8	6.9	5.6	7.0
Georgia	8.6	7.4	8.5	7.3	4.5	7.0	7.0	6.7	5.6	7.2
Florida	8.6	7.3	8.2	7.3	4.8	11.5	8.7	6.8	5.6	8.4
Alabama	8.6	7.3	8.5	7.0	4.8	7.8	6.5	6.7	5.7	7.0
Mississippi	8.8	7.3	8.5	7.0	4.1	7.5	6.7	6.7	5.7	7.0
Louisiana	8.8	7.3	8.4	7.0	4.3	7.8	6.7	6.7	5.7	6.9
Texas	8.4	7.0	8.0	6.9	4.5	7.3	6.5	6.6	5.8	6.8
Arkansas	8.5	7.3	8.5	6.8	4.8	7.6	6.4	6.5	5.8	6.9
Tennessee	8.4	7.3	8.5	6.5	4.5	7.3	6.2	6.6	5.7	7.5
Missouri	8.6	......	7.8	......	4.6	7.4	6.2	6.4	5.8	7.0
Oklahoma	......	......	......	......	4.6	7.5	6.2	6.7	5.8	6.8
Indian Territory	......	......	......	......	......	7.3	......	6.4	5.8	6.9
General average	8.6	7.3	8.4	7.0	4.6	7.6	6.6	6.6	5.7	......

Average yields of wheat, oats, rye, and barley in certain countries.

[From official returns. Bushels per acre.]

WHEAT.

Year.	United States.	Russia.	Germany.	Austria.	Hungary.	France.	United Kingdom.
	(*a*)	(*b*)	(*b*)	(*b*)	(*a*)	(*a*)	(*a*)
1894	13.2	10.8	25.1	17.4	17.8	20.1	31.7
1895	13.7	9.8	24.4	15.3	20.1	19.7	27.2
1896	12.4	9.0	26.4	15.9	19.2	20.0	34.7
1897	13.4	7.3	25.3	13.2	12.1	15.1	30.0
1898	15.3	9.8	27.2	18.0	17.1	21.1	35.8
Average	13.6	9.3	25.7	16.0	17.3	19.2	31.9

OATS.

Year.	United States.	Russia.	Germany.	Austria.	Hungary.	France.	United Kingdom.
	(*a*)	(*c*)	(*c*)	(*c*)	(*a*)	(*a*)	(*a*)
1894	24.5	21.7	46.8	25.9	28.3	27.2	43.7
1895	29.6	19.9	43.2	26.2	28.3	27.5	39.9
1896	25.7	19.2	41.8	23.1	29.4	27.0	39.2
1897	27.2	15.7	39.9	21.5	23.1	23.1	40.1
1898	28.4	16.5	47.1	27.3	30.2	29.0	43.6
Average	27.1	18.6	43.8	24.8	27.9	26.8	41.3

RYE.

Year.	United States.	Russia.	Germany.	Austria.	Hungary.	France.	United Kingdom.
	(*a*)	(*d*)	(*d*)	(*d*)	(*a*)	(*a*)	(*d f*)
1894	13.7	12.7	22.0	17.2	19.3	19.5	25.4
1895	13.4	11.6	20.9	14.5	16.8	18.8	26.8
1896	13.3	10.9	22.7	16.3	18.3	18.7	25.4
1897	16.1	9.3	21.8	13.9	13.9	13.4	21.6
1898	15.6	10.5	24.2	17.7	17.1	18.3	25.8
Average	14.4	11.0	22.3	15.9	17.1	17.7	25.0

BARLEY.

Year.	United States.	Russia.	Germany.	Austria.	Hungary.	France.	United Kingdom.
	(*a*)	(*e*)	(*e*)	(*e*)	(*a*)	(*a*)	(*a*)
1894	19.4	15.3	33.0	22.3	21.2	22.0	35.9
1895	26.4	13.7	31.2	20.9	20.6	21.9	33.1
1896	23.6	12.8	30.7	19.3	22.8	21.8	35.2
1897	24.5	11.8	29.0	17.6	17.3	19.4	33.9
1898	21.6	14.9	32.2	22.0	22.5	23.3	37.4
Average	23.1	13.7	31.2	20.4	20.9	21.7	35.1

a Winchester bushels.
b Bushels of 60 pounds.
c Bushels of 32 pounds.
d Bushels of 56 pounds.
e Bushels of 48 pounds.
f For Ireland only.

Wholesale prices in leading cities of the United States, 1895–1899.

[From Division of Statistics.]

CORN (PER BUSHEL).

Date.	New York. No. 2. Low.	New York. No. 2. High.	Baltimore. No. 2. Low.	Baltimore. No. 2. High.	Cincinnati. No. 2. Low.	Cincinnati. No. 2. High.	Chicago. No. 2. Low.	Chicago. No. 2. High.	Detroit. No. 2. Low.	Detroit. No. 2. High.	St. Louis. No. 2. Low.	St. Louis. No. 2. High.	San Francisco. No. 1, white (per cwt.). Low.	San Francisco. No. 1, white (per cwt.). High.
1895.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*		
January	47	52¾	45	50	42½	45	40½	46	41¼	43¼	40	43¼	$1.22½	$1.27½
February	46¼	49½	44½	50	42¼	45	40⅞	43½	40½	43¼	38	42¼	1.20	1.22½
March	48¼	56	47½	51	43	48½	42¼	45⅜	43	46	41	43⅝	1.20	1.22¼
April	54	56	49¼	53¼	47	50	44⅞	48	45½	48	42½	47	1.17½	1.20
May	54½	60¼	53	60½	49	57	46⅞	54⅞	48	55	45¼	54½	1.12½	1.20
June	51½	57⅝	50	57½	48	55	46⅛	53⅛	48	53	43⅝	49½	1.07½	1.15
July	46½	51¼	48	52	43	51	41⅞	47⅛	43	48½	38½	43⅛	1.07⅛	1.15
August	36½	49⅞	42	51	37½	44	36¼	44½	38⅞	44½	33⅜	39	1.12½	1.17½
September	37	41¾	38	42½	32	39	30¾	36	34	40	27½	33¼	1.12½	1.17⅛
October	36½	40	32	40	31	33¾	28	32	30½	34	26	28½	.95	1.07½
November	34⅞	37⅛	32	37	30	32½	26⅝	29½	28¼	32	24	26¾	.87½	.95
December	32½	35¼	31	34⅛	26	30	24⅛	26¾	26½	29	23½	25½	.82½	.90
1896.														
January	34⅜	37	31½	34	27½	30	25½	28¼	27½	29¼	23⅝	26⅝	.83⅞	.85
February	36	37½	32½	35	29½	31	27⅜	29	28	30	26	27⅜	.81¼	.85
March	37	40	33¼	36½	29½	31	28½	29½	29	30½	26	27¼	.82½	.83¾
April	35	41	34¼	36	31	32¼	28¾	30⅝	28½	32	25¾	27⅝	.85	.91¼
May	33½	35⅞	33	36	30	32½	27½	29½	28	28½	25¼	27¼	.85	.90
June	33	34½	33	36½	29	30	26¼	28⅛	27	29	24⅞	26⅛	.82½	.85⅝
July	30½	34	30	35	27½	30½	24¼	27⅜	25	29	22	25½	.80	.80
August	26½	31¼	26¼	31	24	27½	20½	25	22½	26½	18½	22⅞	.77½	.81¼
September	25¼	27½	26	30	22½	26	19⅛	22¼	20½	24½	17⅝	21	.75	.77½
October	28	34¼	27	35½	26	30	22¼	26½	24½	30	21	24¼	.78⅞	.87½
November	28⅜	31½	23½	30½	22	27	22⅜	25½	22	25	21¼	23½	.87½	.90
December	28⅝	29¼	22	30	22	24	22½	23¾	20½	22	19⅝	21½	.85	.87½
1897.														
January	28¼	29⅞	22	28¼	22½	24	21⅝	23⅝	21½	23	19¼	20⅞	.77½	.87½
February	28	29½	26	29	23½	25	21⅜	23¼	21½	23½	19½	20½	.77½	.82½
March	27	30½	26½	31	24	25½	22⅞	24½	23	25	20⅛	21½	.80	.85
April	25¾	30¾	23½	31	25	30	23½	25¼	24	26	20½	22¾	.81¼	.85
May	29	30⅞	31	34	26½	31	23	25½	23	27	20⅝	24	.82½	.97½
June	28½	30	30	33	26	27½	23¼	25⅝	24	27	21½	23½	.90	.97½
July	28½	33⅝	30	35	27½	29½	24⅛	28¼	26½	28½	21½	25½	.90	.97½

Wholesale prices in leading cities of the United States, 1895-1899—Continued.

CORN (PER BUSHEL)—Continued.

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.
1897.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.		
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	30½	32¾	30	35½	26	28½	25¾	27⅝	25⅜	26½	21⅜	26⅛	.90	.97½
December	31¼	34	27½	35½	27	30	25	27½	26½	30½	24	26⅛	.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	33⅜	31¾	36	30	32½	1.05	1.12½
July	35½	38¾	35	42	34½	37½	31⅞	35½	32	36	30½	33¾	1.07½	1.12½
August	35	38	33	41	31	36½	29¾	33⅞	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	38¼	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	....	....
February	42¼	45	37¾	42	33	37	33¼	37	35⅛	37	33	35	....	....
March	41	45⅛	36	39⅞	35	37½	33	36⅛	34½	36½	33	34¾	....	....
April	41	45½	38	43	36½	37½	34	35½	35½	37½	33½	35	....	....
May	39¼	43½	36¾	38¾	34	36½	32⅛	34⅜	34½	35¼	31½	34½	....	....
June	40⅛	42⅝	37	39½	35	36½	33¼	35½	34½	35	32	33½	....	....
July	37⅜	41½	35	38¾	35	36½	31	34⅞	34	35½	31½	33½	....	....
August	36½	41¼	34⅞	37½	32	34½	30½	33	33½	35	30	31½	....	....
September	38⅝	41⅝	36½	40½	33⅝	35	31¼	35	33¼	35½	30	31	....	....
October	39¾	42⅜	37½	39¼	34	36	31	33	34½	36½	30⅛	31¾	....	....
November	39⅜	41⅞	37½	39⅜	31⅛	35	30⅞	33¼	33	35¼	30	31⅛	....	....
December	39⅗	40⅞	36⅜	33⅞	31½	34	30	31½	32	33½	29½	31	....	....

Wholesale prices in leading cities of the United States, 1895–1899—Continued.

WHEAT (PER BUSHEL).

Date.	New York. No. 2, red winter. Low.	New York. No. 2, red winter. High.	Baltimore. Southern. Low.	Baltimore. Southern. High.	Chicago. No. 2, spring. Low.	Chicago. No. 2, spring. High.	Detroit. No. 2 red. Low.	Detroit. No. 2 red. High.	St. Louis. No. 2, red winter. Low.	St. Louis. No. 2, red winter. High.	Minneapolis. No. 2, northern. Low.	Minneapolis. No. 2, northern. High.	San Francisco. No. 1, California (per cwt.). Low.	San Francisco. No. 1, California (per cwt.). High.
1895.														
January	$0.56	$0.62⅜	$0.55	$0.63	$0.48⅞	$0.55	$0.52½	$0.56¼	$0.48⅝	$0.54½	$0.53½	$0.58	$0.82½	$0.88¾
February	.55½	.58½	.55	.59	.49⅞	.51⅞	.52½	.54¾	.56	.52½	.53¼	.56¼	.81¼	.83¾
March	.58¼	.62¼	.58	.63	.51⅞	.55¼	.54⅜	.58¼	.52¼	.56½	.56¾	.59⅞	.83¾	.90
April	.60	.70	.60	.72	.53⅞	.63¼	.56¼	.67	.54¼	.65	.57¼	.65½	.85	.90
May	.65¾	.83½	.67	.83	.60⅞	.81½	.65	.85	.64	.85	.62¼	.80	.85	.92½
June	.72¼	.84	.70	.83	.69	.81	.71½	.86	.71½	.85½	.69¾	.80¾	.87½	.93⅞
July	.65⅞	.76⅞	.64	.74½	.64	.71½	.65	.74¾	.63¾	.71½	.60½	.69½	.87½	.95
August	.64⅝	.74¼	.61	.72½	.59	.68⅜	.61	.73	.60½	.68½	.57½	.67	.92½	.96¼
September	.60¼	.69½	.57	.68	.55⅛	.62¼	.57½	.67¾	.58½	.64⅝	.53½	.57¾	.90	.95
October	.65⅜	.72½	.64	.69	.57⅞	.61⅜	.62¼	.67¼	.61¼	.65¼	.52½	.55	.95	.97½
November	.66½	.69⅞	.65	.67½	.55⅝	.58¼	.63¼	.65½	.60¼	.63⅝	.51	.52½	.95	.98¾
December	.67¼	.71⅜	.62	.67½	.54	.59½	.63½	.67¼	.61½	.70	.50	.54¼	.98¾	1.02½
1896.														
January	.68½	.78⅞	.66	.76	.57	.64½	.65½	.72¾	.63	.72	.53½	.58	1.01¼	1.12½
February	.78⅝	.82⅝	.74	.78	.62	.67	.72½	.75¾	.71	.74½	.59	.61½	1.12½	1.13¾
March	.76¾	.82⅝	.74	.78	.61	.66½	.68	.74¾	.67¾	.72½	.57¼	.61¼	1.07½	1.12½
April	.73⅝	.83⅝	.73	.78	.61⅞	.67	.67¼	.75½	.65½	.72¾	.58¾	.62⅝	1.07½	1.07½
May	.71⅝	.75¾	.66	.74	.58	.63½	.65	.69	.55¾	.68¼	.55⅞	.60½	1.05	1.07½
June	.63⅞	.76½	.51	.68	.54	.61½	.58	.67½	.52½	.60	.51⅝	.58½	.96¼	1.02½
July	.62	.67½	.53	.64½	.54¼	.59	.57½	.64¾	.52½	.58¾	.52⅛	.55⅝	.92½	.95
August	.64⅞	.68⅝	.57	.65½	.54	.59	.61½	.64⅞	.58	.64	.50	.54⅝	.93⅝	.96¼
September	.65	.77⅝	.59	.71¾	.55½	.67½	.59⅝	.71	.56¼	.58¼	.51	.64	.96¼	1.06¼
October	.77⅛	.90½	.69	.84	.67	.77	.70½	.84½	.68	.80½	.63½	.75	1.15	1.33¾
November	.85¾	1.02⅝	.76	.96	.72	.82	.80½	.97	.76	.91	.73	.81¼	1.48¾	1.50
December	.99⅞	1.06⅘	.88	.96	.76½	.81½	.90	.96¾	.89	.92⅝	.74½	.80⅘	1.47½	1.50
1897.														
January	.91¾	1.01⅜	.87	.97	.73	.81	.85	.94⅞	.80	.92½	.71⅝	.79⅝	1.50	1.56¼
February	.88¼	.96¾	.87	.92	.72½	.76½	.85	.89	.80⅞	.89⅝	.71⅛	.73⅝	1.32½	1.40
March	.81⅝	.89⅛	.83	.92	.71	.76	.85	.91½	.90⅞	.95½	.69⅝	.74½	1.28¾	1.36¼
April	....	....	.73	.85	.66½	.77½	.83½	.93¾	.90	1.03	.65¼	.77⅝	1.21¼	1.30
May	....	....	.80	.90	.68¾	.76	.79½	.92½	.82½	.97	.69¼	.75	1.30	1.32½
June	....	....	.55	.81	.67	.73	.76	.83	.74	.84½	.68½	.71⅞	1.22½	1.23¾
July	....	....	.50	.85	.68½	.78¾	.74½	.79¼	.65½	.79	.69¾	.79¾	1.21¼	1.40
August	.86⅗	1.11⅛	.80	1.07⅛	.76	1.00	.77½	1.01	.79	1.03	.79¼	1.07½	1.46¼	1.55

Wholesale prices in leading cities of the United States, 1895–1899—Continued.

WHEAT (PER BUSHEL)—Continued.

Date.	New York. No. 2, red winter. Low.	New York. No. 2, red winter. High.	Baltimore. Southern. Low.	Baltimore. Southern. High.	Chicago. No. 2, spring. Low.	Chicago. No. 2, spring. High.	Detroit. No. 2, red. Low.	Detroit. No. 2, red. High.	St. Louis. No. 2, red winter. Low.	St. Louis. No. 2, red winter. High.	Minneapolis. No. 2, northern. Low.	Minneapolis. No. 2, northern. High.	San Francisco. No. 1, California (per cwt.). Low.	San Francisco. No. 1, California (per cwt.). High.
1897.														
September	$0.94⅛	$1.07½	$0.89	$1.04½	$0.85	$1.00	$0.91½	$1.00	$0.93¼	$1.01	$0.85	$0.96¼	$1.47½	$1.56¼
October	.94⅜	1.05	.88	1.01	.83	.90	.91	.97½	.93½	1.01	.85	.92½	1.45	1.47½
November	.97¾	1.03½	.90	1.01	.87	.91	.91	.97	.94¾	.99¾	.87¼	.92½	1.40	1.48¾
December	.97	1.03¼	.91	1.00	.86	.92	.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	1.14¼	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	.63¾	.88	.66½	.90	.64⅛	.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	.71⅘	.60	.63	1.15	1.21¼
December	.73⅞	.81¼	.62	.77	.62¾	.70	.66¾	.72¼	.68½	.73	.60	.67	1.13¾	1.15
1899.														
January	.79¼	.87⅝	.76	.81½	.66½	.76	.70½	.76½	.71	.79½	.65½	.72¼	1.12½	1.18¾
February	.81	.87⅝	.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	.87¼	.73¼	.79½	.68⅜	.79½	.73¼	.80	.73¼	.81⅝	.67¼	.73	1.06¼	1.12½
June	.80	.85⅝	.75	.79	.71¼	.79¼	.75¼	.80¼	.73¾	.78½	.70½	.73⅞	1.10	1.12½
July	.75⅞	.81¾	.71	.75¾	.68⅝	.75⅝	.71¼	.78	.69⅝	.75	.65⅝	.71⅜	1.05	1.10
August	.74⅝	.78½	.71	.73¼	.69	.74½	.70	.74	.68⅛	.73¼	.66	.70¼	1.03¾	1.07½
September	.73¾	.77⅝	.70½	.74½	.69⅝	.75⅛	.70½	.73½	.68	.72	.64⅞	.67⅞	1.02½	1.07½
October	.75	.78¾	.71	.75½	.68⅝	.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

Wholesale prices in leading cities of the United States, 1895-1899—Continued.

OATS (PER BUSHEL).

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, white.		No. 1. white (per cwt.).	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1895.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*		
January	33	34¾	31	36	23¼	33	27½	28¾	30¼	32	29½	31	33	33⅝	$0.92½	$0.97½
February	33½	34¼	33½	35	30¼	32	25½	25½	30½	32¼	29½	30½	33	34	.92½	.95
March	33⅓	34	33½	35½	31	32¼	28	29½	31¼	32¾	30	31½	33½	34½	.92½	.97½
April	31⅝	33¾	33½	34½	30½	32¼	27½	29½	31⅞	33	30½	31¼	33¼	34⅝	.97½	1.00
May	31¼	33⅝	33½	35	30½	32	27¼	30¾	31⅝	34	30½	32½	33¾	35	.97½	1.00
June	27¾	34	32	34½	29½	31½	25	30¾	28¾	33¼	25	27½	32¼	35	.92½	1.00
July	26⅝	29	29½	32	26	28⅞	22½	25¼	26½	29½	19½	25½	27½	31⅜	.90	.95
August	21	28½	24¾	30	21	27	18⅝	22⅜	20½	27¾	18½	20	23	28	.90	.92½
September	23½	24¼	24	25	21¼	23	18	20½	20½	23½	18	20¼	22½	24½	.72½	.90
October	22½	24½	23	25	19	21½	17½	18¾	19	22½	18	19	21	23½	.70	.75
November	22⅝	24¾	22	23½	19¼	22	17½	18⅞	19	21	17⅞	19	21¼	22⅞	.67½	.72½
December	23⅛	23¼	22½	23	19½	21⅝	16⅝	17½	18	20½	15½	18¼	20½	21½	.75	.80
1896.																
January	23¼	25	22½	23½	19⅝	22	17	19½	18¼	21	15½	19	20½	23	.75	.80
February	24¾	25⅞	23½	27	21¼	23	19¼	20¼	20	22	18	19	22½	23¼	.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	15½	18½	18	20	15¼	19	18¾	22	.82½	.87½
July	20¼	22⅞	20	25	17¼	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	18¼	14¾	17¼	16½	21	15¾	19¾	18½	22	.87½	.90
October	21	23¾	20½	23	17	20	17¼	19¾	17	21½	17½	20½	20	22¼	.90	1.07½
November	22⅝	24	22	23½	19	21½	17½	19⅝	16½	22¼	17½	19	20¼	21¼	1.07½	1.15
December	22	23½	21	23	18½	20½	16½	18⅝	17⅝	21½	17¾	19	19¾	21½	1.12½	1.15
1897.																
January	21½	22½	21	22	18½	20	15⅞	17	18	19½	16¼	18¾	19¼	20	1.27½	1.30
February	21	21¾	21	22	16¾	19½	15½	16½	16½	19½	16¼	17¼	19¾	20	1.27½	1.30
March	21¼	22¼	21	23½	17½	21	16	17	17½	20¾	16½	17½	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	23¼	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

Wholesale prices in leading cities of the United States, 1895–1899—Continued.

OATS (PER BUSHEL)—Continued.

Date.	New York. No. 2, mixed. Low.	New York. No. 2, mixed. High.	Baltimore. No. 2, mixed. Low.	Baltimore. No. 2, mixed. High.	Cincinnati. No. 2, mixed. Low.	Cincinnati. No. 2, mixed. High.	Chicago. No. 2. Low.	Chicago. No. 2. High.	Milwaukee. No. 2, white. Low.	Milwaukee. No. 2, white. High.	Duluth. Low.	Duluth. High.	Detroit. No. 2, white. Low.	Detroit. No. 2, white. High.	San Francisco. No. 1, white (per cwt.). Low.	San Francisco. No. 1, white (per cwt.). High.
1897.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*		
September	23¼	25	21	23½	19½	21¾	18⅞	20⅝	21	23½	20⅝	23	22⅝	23¼	$1.27½	$1.30
October	22½	24½	22¾	23½	20	21⅝	17¾	19⅝	21	22⅝	20¼	21½	22	23¼	1.17½	1.27½
November	24½	26½	23	27	20½	24½	19½	22¼	22¼	24½	21½	22⅝	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	23⅝	25¼	23½	25	24½	26¾	1.15	1.22½
February	29	32	28	33	25½	28¾	24	27	24⅝	29	24	28	26½	32¼	1.20	1.22½
March	30	32	30	32½	27½	29	24⅞	26¾	28	30	24⅝	27½	29⅝	30⅝	1.20	1.32½
April	29¾	35½	30	35	28	31	25	31⅞	28	33	25	32⅝	30½	32½	1.32½	1.42½
May	32½	36	33	36	29	34½	26	32	28⅝	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	23⅝	23¼	25⅝	1.17½	1.27½
October	25¾	29½	25½	28	23	26½	21½	25	24	27¾	23	25½	24⅝	29	1.22½	1.27½
November	29	30⅛	27½	32	26½	29	24¼	27⅝	27	30	25	27	28¼	29½	1.22½	1.27½
December	30⅝	33¾	31½	32½	28	30	26	27⅝	22¾	30	26⅝	30	29½	30⅝	1.27½	1.32½
1899.																
January	33	35	32	33½	28½	31	26¼	27⅝	28⅝	31¼	28⅝	30½	30½	33	1.30	1.37½
February	34¼	35½	33	35	28⅝	31½	26⅝	28¼	29½	31½	28¼	30	32½	33	1.32	1.40
March	32	35¼	32	34	28½	31	25½	27¾	28⅝	30⅝	25⅝	29¼	31	32⅝	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	32¼	29½	33	27½	29½	24	27⅝	26⅝	31	26½	28	30¼	32¾	1.40	1.45
June	30½	31½	29½	31	27	29	24¼	26¼	27¼	29¼	26⅛	28½	28⅝	30¼	1.37½	1.42½
July	28	30½	28½	31	22	28½	19⅞	25	24	28⅝	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	25⅝	29	25	28	22½	25½	21	23¼	22⅝	26	20¼	24	23¾	28½	1.27½	1.30
October	28½	29¼	27½	29	24⅝	26	22	23½	24⅝	26	22¼	24¼	26	27½	1.25	1.30
November	28½	30	27½	29½	25¼	26½	22½	24	25½	26½	22½	23⅜	27	28	1.25	1.30
December	28½	30	28	29½	25½	26¼	22¼	23	24⅝	25½	22½	23¼	26⅛	27½	1.22½	1.27½

Wholesale prices in leading cities of the United States, 1895–1899—Continued.

RYE (PER BUSHEL).

Date.	New York. Prime State. Low.	New York. Prime State. High.	Cincinnati. No. 2. Low.	Cincinnati. No. 2. High.	Chicago. No. 2. Low.	Chicago. No. 2. High.	Duluth. Low.	Duluth. High.
1895.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	54	56½	54¼	55¼	48	50½	46	46
February	54	55	54¼	58½	50	53½	46	46
March	54	55	57½	60	51	55	46	49
April	57	65	58	75	54	66	49	61
May	--------	--------	62	73	62½	67	61	63
June	--------	--------	63	72	59½	70	50	63
July	--------	--------	45	63	46	58	45	49
August	55	57	42	50	39	45	37½	43
September	45	55	42	46	37	40	34½	37½
October	45	48	41	46	37	41	35	39
November	42	47	40	42	35¼	37	32	36
December	45	45	40	42	32	35¾	29	32½
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	35½	37½	34	36
May	43½	45⅝	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	35½
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	54½	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
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

Wholesale prices in leading cities of the United States, 1895–1899—Continued.

BARLEY (PER BUSHEL).

Date.	New York. No. 2, western. Low.	New York. No. 2, western. High.	Cincinnati. No. 2, fall. Low.	Cincinnati. No. 2, fall. High.	Chicago. No. 3. Low.	Chicago. No. 3. High.	San Francisco. No. 1, brewing. Low.	San Francisco. No. 1, brewing. High.
1895.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cwt.*	*Cwt.*
January	63	65	58	59	55	56	$0.87½	$0.97½
February	63	64½	58	59	54	56½	87½	.90
March	61	65	58	59	53	55	90	.92½
April	57	64	58	59	51½	54	87½	.90
May	....	....	58	59	51	52	87½	.90
June	....	....	58	59	51	54	65	.72½
July	....	....	58	59	52	52	70	.73¾
August	....	....	58	59	....	....	72½	.75
September	44	50	58	59	40	48	70	.75
October	40	50	....	....	38	43	67½	.72½
November	35	50	....	....	36	42	70	.80
December	40	48	....	....	33	40	77½	.80
1896.								
January	38	47	....	....	23	40	80	.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	36	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	$0.87½	$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
1899.			Extra No. 3, spring.					
January	57	62	50	56	41	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	46	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

Wholesale prices in leading cities of the United States, 1895-1899—Continued.

POTATOES.

Date.	New York. Burbank, per 180 pounds.		Chicago. Burbank, per bushel.		Milwaukee. Per bushel.		St. Louis. Burbank, per bushel.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1895.								
January	......	......	$0.44	$0.60	$0.40	$0.65	$0.57	$0.65
February	......	......	.50	.68	.50	.70	.60	.63
March	......	......	.52	.72	.55	.70	.65	.82
April	......	......	.60	.75	.60	.75	.65	.80
May	......	......	.40	.70	.40	.70	.60	.65
June	......	......	.20	.55	.20	1.00	.55	.63
July	......	......	......	......	.30	.95	.50	.80
August	......	......	......	......	.30	.50	......	......
September	......	......	.23	.28	.20	.35	......	......
October	......	......	.17	.28	.15	.35	.20	.33
November	......	......	.17	.26	.15	.25	.23	.30
December	......	......	.18	.24	.15	.25	.21	.30
1896.								
January	......	......	.18	.24	.15	.25	.22	.27½
February	......	......	.18	.23	.15	.25	.22	.27
March	......	......	.16	.21	.12	.25	.20	.24
April	......	......	.16	.22	.12	.22	.20	.27
May	......	......	.10	.23	.10	.22	.23	.30
June	......	......	.10	.20	.10	.25	.20	.45
July	......	......	......	......	.10	.35	.20	.20
August	......	......	......	......	.23	.30	......	......
September	......	......	.21	.31	.23	.35	......	......
October	......	......	.18	.25	.18	.30	.27	.35
November	......	......	.18	.26	.18	.25	.21	.32½
December	......	......	.18	.26	.18	.25	.27	.30
1897.								
January	......	......	.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
May	......	......	.19	.26	.15	.25	.24	.28
June	......	......	.18	.38	.15	1.00	.27	.40
July	......	......	$0.23	$0.28	$0.20	$1.00	......	......
August	......	......	......	......	.50	.70	$0.55	$0.58
September	......	......	.52	.58	.35	.50	.50	.65
October	......	......	.38	.52	.35	.45	.40	.60
November	......	......	.40	.55	.35	.55	.37	.53
December	......	......	.50	.62	.45	.55	.53½	.65
1898.								
January	$2.12	$2.50	.57	.62	.45	.55	.60	.68
February	2.12	2.50	.57	.64	.50	.60	.62	.68
March	2.25	2.75	.60	.67	.50	.60	.58	.70
April	2.25	3.00	.58	.66	.45	.75	.52½	.75
May	2.00	3.12	.60	.87	.50	.90	.60	.85
June	1.50	3.25	.32	.65	.35	.65	.55	.70
July	1.50	3.00	.44	.50	.35	.80	.40	.50
August	1.25	2.00	......	......	.35	.50	......	......
September	1.37	2.00	.32	.48	.30	.40	.35	.50
October	1.25	2.00	.29	.36	.25	.35	.35	.43
November	1.25	1.50	.29	.35	.25	.30	.30	.41
December	1.25	1.62	.30	.36	.25	.30	.33	.40
1899.								
January	1.25	1.62	.34	.38	.20	.35	.39½	.45
February	1.25	2.00	.34	.50	.20	.45	.42	.55
March	1.25	2.37	.48	.75	.30	.65	.53	.75
April	2.00	2.37	.49	.68	.40	.60	.56	.72
May	1.00	3.50	.33	.52	.20	.55	.40	.55
June	1.00	3.50	.34	.60	.15	.40	.42	.52
July	.50	3.00	.28	.28	.20	.90	......	......
August	.75	2.00	......	......	.20	.35	.25	.30
September	.75	1.50	.30	.40	.20	.30	.32	.40
October	.75	1.65	.26	.32	.18	.30	.32	.40
November	.75	1.50	.31	.42	.18	.35	.33	.44
December	.90	2.00	.35	.46	.25	.40	.43	.48

Wholesale prices in leading cities of the United States, 1895–1899—Continued.

HAY (BALED).

Date.	New York. No. 1, per hundredweight. Low.	New York. No. 1, per hundredweight. High.	Chicago. No. 1 Timothy, per ton. Low.	Chicago. No. 1 Timothy, per ton. High.	Cincinnati. No. 1 Timothy, per ton. Low.	Cincinnati. No. 1 Timothy, per ton. High.	St. Louis. Choice Timothy, per ton. Low.	St. Louis. Choice Timothy, per ton. High.
1895.								
January	$0.70	$0.75	$10.00	$10.25	$10.00	$10.75	$10.75	$11.75
February	.65	.70	10.00	10.25	10.00	10.50	10.50	11.75
March	.70	.75	10.00	10.25	10.00	10.50	10.75	11.50
April	.70	.75	10.00	10.25	10.00	11.00	10.50	11.75
May	.70	.80	10.00	10.25	10.75	11.00	11.00	11.75
June	.70	.85	10.50	14.00	11.00	19.00	11.00	17.00
July	.80	.95	14.00	14.50	15.00	17.00	14.50	16.00
August	.80	1.05	12.50	13.00	12.50	14.00	13.00	17.25
September	.80	.90	12.00	12.50	13.00	14.00	12.50	14.50
October	.80	.90	12.00	12.50	13.75	14.75	12.50	15.00
November	.85	.85	12.00	12.50	14.00	15.00	12.50	15.00
December	.85	.90	12.00	12.50	13.75	14.75	13.00	15.50
1896.								
January	.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
May	.80	.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

Date.	New York. No. 1, per hundredweight. Low.	New York. No. 1, per hundredweight. High.	Chicago. No. 1 Timothy, per ton. Low.	Chicago. No. 1 Timothy, per ton. High.	Cincinnati. No. 1 Timothy, per ton. Low.	Cincinnati. No. 1 Timothy, per ton. High.	St. Louis. Choice Timothy, per ton. Low.	St. Louis. Choice Timothy, per ton. High.
1897.								
July	$0.77½	$0.80	$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	9.25	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
1898.							No. 1 Timothy.	
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

Wholesale prices in leading cities of the United States, 1895–1899—Continued.

HOPS (PER POUND).

Date.	New York. Choice State. Low.	New York. Choice State. High.	Cincinnati. Choice. Low.	Cincinnati. Choice. High.	Milwaukee. Wisconsin. Low.	Milwaukee. Wisconsin. High.	Chicago. Pacific coast, common to choice. Low.	Chicago. Pacific coast, common to choice. High.
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1895.								
January	11	11	10	11	7	10	8	11
February	10½	11	10	11	7	10	8	11
March	10½	10½	9½	11	6½	10	7	10
April	9	10	9	11	6	9	6	9
May	8½	9	9	10	5	8	6	9
June	8	8½	8	9½	5	7	6	9
July	8½	9	8	9	5	7	6	9
August	6½	8½	6½	8½	5	7	5	9
September	6½	10	6	9	6	8	8	10
October	9½	9½	9	10	6	8	7	10
November	9	10	9	10	5	7½	7	9
December	9	10	8	9	5	7	5	9
1896.								
January	8	9	7	9	6	8	5	8
February	7½	8	7	8	5	8	5	8
March	7½	8	6	8	5	8	5	7
April	7½	8	6	7½	5	8	5	7
May	7	7½	6	7½	5	8	5	7
June	7½	7½	6	7	5	8	5	7
July	7	7½	6	7	5	8	5	7
August	7	7	6	7	5	7	4	7
September	7	9	6	7	5	7	4	7
October	9	11	10	12	5	7	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	12	13	15	17
November	15	17	16	18	12	13	10	17
December	16	18	18	18	12	13	12	17
1898.								
January	18	19	16	16	12	13	10	17
February	18	19	16	16	12	15	10	17
March	17	18	16	16	14	15	10	17
April	15	17	15	15	14	15	10	16
May	12	15	16	16	14	14	10	14
June	12	13	15	15½	14	14	10	13
July	11	12	14	15	14	14	8	10
August	11	12	14	14	13	14	5	10
September	11	15	14	14	13	14	5	10
October	15	19	14	19	15	16	16	18½
November	18	20	20	20	15	16	15	19
December	18	20	19	19	15	16	16	19
1899.								
January	18	18	19	19	15	16	15	18
February	18	18	18	19	15	16	12	18
March	17	18	18	19	15	16	13	18
April	15	17	18	18½	15	16	13	18
May	16	16	16½	18	15	16	12	18
June	15	16	16	18	15	16	12	18
July	15	16	16	18	15	16	12	18
August	14	15	16	17	15	16	12	18
September	12	13	16	16	15	16	12½	16
October	13	15	13	13	14	15	9	16
November	13	14	13½	13½	14	14	9	13
December	12½	14	13	13	14	14	7	13

Wholesale prices in leading cities of the United States, 1895–1899—Continued.

FLAXSEED (PER BUSHEL).

Date.	New York. Domestic. Average.	Cincinnati. Low.	Cincinnati. High.	Chicago. No. 1. Low.	Chicago. No. 1. High.	Milwaukee. Low.	Milwaukee. High.
1895.							
January		$1.12	$1.12	$1.38½	$1.43	$1.39	$1.43
February		1.12	1.12	1.39½	1.44	1.37½	1.44
March		1.12	1.12	1.37½	1.42½	1.38½	1.42½
April		1.12	1.12	1.38¾	1.43½	1.37½	1.44
May		1.12	1.12	1.46½	1.51½	1.44	1.51
June		1.12	1.25	1.47	1.52½	1.47	1.52½
July		1.25	1.25	1.19	1.47	1.20	1.47
August		1.00	1.25	.99½	1.16	.99¾	1.15
September		1.00	1.00	.90¾	1.04	.91	1.04
October		1.00	1.00	.89	.99½	.89½	.99
November		.90	1.00	.90½	.93¾	.91	.93½
December		.90	.90	.91½	.94½	.91½	.94½
1896.							
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	.82½
July		.80	.80	.70½	.76	.70	.76
August	$0.75¼	.65	.80	.63½	.73¼	.63½	.73
September	.73¾	.65	.70	.63¼	.78½	.63½	.78
October	.80¼	.65	.70	.68½	.79¾	.69½	.78
November	.85 9/16	.65	.70	.70¼	.79½	.71	.79½
December	.87¼	.65	.70	.71½	.79½	.73½	.79
1897.							
January	.88	.65	.70	.73	.78¼	.75	.78
February	.85 13/16	.65	.70	.73¾	.77¾	.75½	.77½
March	.87¾	.65	.70	.75¾	.81¼	.78	.81½
April	.84 3/16	.65	.70	.71½	.80	.75	.80
May	.83¼	.65	.70	.76	.79¾	.76½	.79
June	.81 9/16	.65	.70	.75	.80	.76	.80½
July	$0.84 7/16	$0.65	$0.70	$0.77	$0.89	$0.77½	$0.89
August	1.06 13/16	.65	.75	.87¾	1.20	.88½	1.20
September	1.11⅜	.70	.85	.96¾	1.09	.98	1.09½
October	1.08	.80	.85	.91	1.07½	.91	1.08
November	1.11⅛	.80	.85	1.02	1.10½	1.06½	1.11
December	1.16	.80	.85	1.04½	1.22½	1.09	1.22½
1898.							
January	1.22	.85	.90	1.16	1.32	1.19½	1.32
February	1.20	.85	.90	1.22	1.30½	1.25½	1.30½
March		.85	.90	1.17	1.25½	1.18	1.25½
April		.85	.90	1.16½	1.31½	1.18½	1.31
May		.85	.90	1.23	1.39	1.26	1.39
June		.85	.90	1.05	1.22	1.05½	1.22½
July		.85	.90	.86½	1.07	.90	1.04½
August		.80	.85	.86	.93	.88	.93
September	.95½	.80	.80	.86½	.93	.89	.92¾
October	.99½	.80	.80	.89	1.07	.90½	1.07
November	1.05⅛	.80	.90	.97	1.08½	.98	1.08
December	1.08⅝	.90	.90	.97¾	1.18	1.03½	1.19
1899.							
January		.90	.90	1.10½	1.20	1.15	1.20
February		.90	.90	1.13½	1.20½	1.18	1.20½
March		.90	1.00	1.14	1.25	1.18	1.24½
April		1.00	1.00	1.12	1.25	1.17	1.25
May		.90	1.00	1.02	1.17½	1.03½	1.17½
June		.90	.90	1.00½	1.10	1.08	1.09
July		.90	.90	.97	1.04½	.99	1.05
August		.90	.90	.96½	1.20	1.00	1.20
September		.90	.90	1.04½	1.21	1.06	1.20
October		.90	1.00	1.14	1.32½	1.14	1.32½
November		1.00	1.00	1.28½	1.39¼	1.26½	1.39
December		1.00	1.00	1.39	1.51	1.39	1.52

Wholesale prices in leading cities of the United States, 1895–1899—Continued.

BUTTER (PER POUND).

Date.	New York. Creamery extra. Low.	New York. Creamery extra. High.	Cincinnati. Creamery. Low.	Cincinnati. Creamery. High.	Chicago. Creamery firsts. Low.	Chicago. Creamery firsts. High.	St. Louis. Creamery extra. Low.	St. Louis. Creamery extra. High.
1895.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	23	26½	18	21	21	25	23½	27
February	23½	26	18	20	20	23½	23	25
March	19	23	15	17	16	22½	19	24
April	19	21½	15	20	17	20½	22	22
May	17	19	14	17	14½	18	18	20
June	17½	20	13	17	15½	17½	19½	20
July	17	18½	13	16	15	17½	19	20
August	18	20½	15	18	16	20	20	22
September	20	22	15	18	18	20½	22	24
October	22	23	16	20	18	22	24	24
November	23	24	16	21	18	22½	24	25
December	24	28	16	24	21	26½	25	28
1896.								
January	20	25	15	18	17	24	21	24
February	18	22	15	16	16½	21½	19	22
March	21	22	15	17	19	21½	22	22½
April	14	21	12	15	13	21	15	21
May	15	16	12	13	13	15½	16	17
June	15½	15½	12	13	13	15	15	16
July	15	15½	12	14	12½	14½	15	16
August	15	16½	12	15	12	16½	15	18
September	15	16½	12	15	12	16	15½	18
October	16	20	13	16	13	19	16½	21
November	20	23	15	20	16	22	19	23
December	21	24	16	20	18	23	21	24
1897.								
January	20	22	15	16	17	21	20	21
February	19	21½	15	17	16	20½	18½	22
March	19	20	15	20	16	19	18½	19
April	17	22	13	20	14	21	16½	22
May	14	17	12	14	12½	16	13½	16½
June	15	15	12	13	13	15	14	15
July	15	15	12	13	12½	14½	14½	15
August	15	18½	12	18	12½	18½	14½	19
September	18	21	15	18	15½	20½	17½	23
October	21	23½	16	22	19	23	23	24
November	23	23½	14	18	19	23	22	24
December	22	24	18	20	18	23	21½	23½
1898.								
January	20	22	16	20	16	21	20	21
February	20	20½	16	18	16	19½	19	19½
March	19	20½	16	18	16	20	18½	20
April	17	22	14	18	15	21	17	21
May	15	17	14	16	14	16½	15	16
June	16	17	13	15	14½	16	15½	16
July	16½	18½	14	15	14½	17½	16	18
August	18½	19	16	17	16	18½	18½	19
September	18½	31	16	18	15½	20	18½	21
October	20½	23	16	18	17	22	21	23
November	23	23½	18	19	19	22	22	23
December	20	23½	17	18	16	22	20	23
1899.								
January	19	21	16	18	14	20½	19	21
February	19	25	17	20	14	21½	19	23½
March	20	22	19	20	17	21	20½	22
April	17	21½	18	19	14	21	17	21½
May	16½	19	16	17	14	18½	17	17½
June	18	18½	17	18	16	18	18	19
July	17½	18½	16½	18	15½	18	18	18
August	17½	21	16½	20	15½	20	18	21
September	20½	23	18	20	17½	22½	20	23½
October	23½	24	18	20	18	23	23½	24½
November	24	27	18	24	19	26	24½	26½
December	26½	28	21	24	21	27	26	27

Wholesale prices in leading cities of the United States, 1895–1899—Continued.

EGGS (PER DOZEN).

Date.	New York. Average best fresh.		Cincinnati.		Chicago. Fresh.		St. Louis. Average best fresh.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1895.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	22½	25	17½	23	17½	20	14	19
February	24	34	20	26	22	30	19	25
March	11¾	30½	9¾	15	10	31	9	21
April	12¼	13¼	10	11	11	12½	9½	11¼
May	12½	15	10	11	9	12½	9	11
June	11½	14½	10	10½	9½	12	8	10¾
July	12½	13½	8	9	10	12	7½	8½
August	13	15	9	9	10	13½	8½	11
September	14½	17½	10	12	13	16	9	12½
October	16	20	12	15	15	17	12½	15½
November	19½	23½	16	17	15	21	15½	19
December	21	24	16	19	15	22	17	20
1896.								
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

Wholesale prices in leading cities of the United States, 1895–1899—Continued.

CHEESE (PER POUND).

Date.	New York. September, colored. Low.	New York. September, colored. High.	Cincinnati. Factory. Low.	Cincinnati. Factory. High.	Chicago. Full cream. Low.	Chicago. Full cream. High.	St. Louis. Full cream. Low.	St. Louis. Full cream. High.
1895.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	11¼	11¼	9½	10½	9½	10½	11	11¼
February	11¼	11½	9½	10½	10	10½	11	11¼
March	11½	11½	9½	10	10	10⅞	11	11¼
April	8	11½	9½	10	10	11	10½	11
May	6	8	7	9	8½	11	8¼	9¾
June	6¾	8⅛	7	8½	6	8½	8⅛	9
July	7⅝	8⅜	7	8½	7	8¼	8½	9
August	7¼	8	7½	8½	7	7⅜	8¼	9¼
September	7¼	8⅛	8	8½	7¼	8½	8¼	9¼
October	8¼	10	8	9½	7½	9½	8⅞	10¼
November	9¾	10½	9	10	9	9⅝	9½	10½
December	9¾	10	9½	10	9	9½	9	10¼
1896.								
January	10	10¼	9½	10	7½	9¼	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	7½	8	8½
July	6¾	6⅞	7	8	6	7½	7⅞	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	9½	9½	10
December	10⅜	10½	9½	10	7	9½	9½	10
1897.								
January	10¼	11⅜	9	10	3	10	9¾	10¾
February	12	12½	9	10½	4	11	10¼	11¾
March	12½	12½	10	10½	4	11	11¼	11½
April	10½	12½	10½	11	3	11	11¼	11¼
May	8½	10	8½	11	3	10½	8¾	11½
June	8	8⅜	7	8	3	8¼	8	8½
July	7½	8	7	8	4	8¼	8	8½
August	7⅞	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	7⅞	7	8	7¾	8¼	8¼	8¼
August	7	7⅞	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	12½	12½	12½
May	8½	12	9½	12	9½	11½	10½	12½
June	7½	8¾	8	10	8	9½	9	9¾
July	8	9½	8½	9½	8¼	9	9¼	10¼
August	9½	11¼	9	11	8⅞	10	10¼	10½
September	11¼	11⅞	10¾	12	10	11¾	11⅞	12½
October	12	12⅞	12	12½	11¼	12¼	13	13
November	12½	12¾	12½	12½	11	12¼	12	13
December	12¾	13	12	12½	11	13	12½	12½

Wholesale prices in leading cities of the United States, 1895–1899—Continued.

LIVE HOGS (PER 100 POUNDS).

Date.	Cincinnati. Packing, fair to good.		St. Louis.		Chicago.		Omaha.	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.
1895.								
January	$4.00	$4.50	$4.15	$4.45	$3.70	$4.80	$3.25	$4.45
February	3.90	4.55	3.50	4.45	3.60	4.65	3.35	4.30
March	4.25	5.15	3.75	4.90	3.85	5.30	3.50	5.00
April	4.75	5.25	4.30	5.10	4.40	5.40	4.30	5.10
May	4.50	4.90	4.00	4.95	4.10	4.97½	3.90	4.70
June	4.40	4.90	4.00	4.70	4.20	5.10	4.00	4.85
July	5.00	5.35	4.25	5.35	4.50	5.70	4.50	5.10
August	4.45	4.95	4.30	5.15	3.85	5.40	4.00	4.75
September	4.25	4.40	3.60	4.50	3.55	4.65	3.50	4.42½
October	3.65	4.20	3.25	4.30	3.20	4.50	3.25	4.15
November	4.25	4.75	3.00	3.90	3.20	3.85	3.25	3.60
December	4.10	4.70	2.80	3.55	3.25	3.75	3.20	3.50
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
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

Wholesale prices in leading cities of the United States, 1895–1899—Continued.

UPLAND MIDDLING COTTON (PER POUND).

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.
1895.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	5 5/8	5 7/8	5	5 3/16	5 1/16	5 1/8	5 1/16	5 3/16	5	5 1/8	5 1/8	5 1/4	4 1/8	5	5 1/8	5 1/4
February	5 9/16	5 3/4	5	5 3/16	5 1/16	5 1/8	5 1/16	5 3/16	5 1/16	5 1/8	5 1/8	5 3/16	4 7/8	5	5 1/16	5 3/16
March	5 9/16	6 7/16	5 1/16	5 1/4	5 1/16	5 13/16	5 1/4	5 1/4	5	5 15/16	5 1/8	5 3/8	5	5 3/8	5 1/16	5 1/4
April	6 3/8	7	5 3/4	6 3/8	5 3/4	6 3/8	5 3/4	6 7/16	5 13/16	6 3/8	6	6 3/8	5 3/4	6 1/2	5 13/16	6 1/2
May	6 3/8	7 3/8	6 1/8	7	6 1/4	6 13/16	6 1/4	6 13/16	6 5/16	6 13/16	6 1/8	6 3/4	6 1/4	6 5/8	6 1/4	6 5/8
June	7	7 1/4	6 5/8	7	7	7 1/8	6 5/8	6 5/8	6 5/8	6 3/4	6 1/8	6 3/4	6 5/8	6 7/8	6 3/8	6 3/4
July	7	7 3/16	6 1/2	6 3/4	6 1/2	6 3/4	6 5/8	6 11/16	6 5/8	6 11/16	6 5/8	6 5/8	6 3/4	7	6 5/8	7
August	7 1/2	8 3/16	6 1/2	7 11/16	6 7/8	7 11/16	6 5/8	7 3/4	6 11/16	7 5/8	6 5/8	7 1/2	6 7/8	7 1/2	7	7 5/8
September	8 1/8	9 1/8	7 5/8	8 1/4	7 11/16	8 1/4	7 7/8	9 1/4	7 5/8	8 5/8	7 5/8	8 5/8	7 1/8	8 5/8	7 5/8	8 5/8
October	8 1/2	9 3/8	8 5/16	9 3/16	8 5/8	8 15/16	8 1/4	9 11/16	8 1/8	8 11/16	8	8 3/4	8 1/4	9	8 1/4	9
November	8 3/4	9	8 1/8	8 5/16	8 1/16	8 5/8	8 1/16	8 5/8	7 7/8	8 7/16	7 7/8	8 1/2	8	8 5/8	8	8 5/8
December	8 1/4	8 9/16	7 11/16	8 3/16	7 13/16	8 1/4	7 7/8	8 1/4	7 11/16	8 1/8	7 7/8	8 1/8	7 3/4	8 1/4	7 3/4	8 1/4
1896.																
January	8 3/16	8 5/8	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 5/8	7 3/4	7 1/2	7 7/8	7 9/16	7 15/16
March	7 5/8	8	7 5/8	7 13/16	7 5/8	7 3/4	7 5/8	7 13/16	7 5/16	7 7/8	7 1/4	7 1/2	7 5/8	7 1/2	7 5/8	7 3/4
April	7 5/8	8 1/8	7 3/8	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 5/8	7 5/8	7 3/4	7 7/16	7 9/16	7 7/16	7 7/8	7 1/2	7 5/8	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 5/8	7	7 5/8	6 5/8	7 5/8	7	7 1/2	6 5/8	7 1/2	7 1/2	7 1/2	7 1/2	7 1/4
July	7 1/16	7 1/16	6 1/2	6 13/16	6 5/8	6 7/8	6 5/8	6 9/16	6 5/8	7	6 5/8	6 5/8	7	7 1/2	6 3/4	7 1/2
August	7 7/16	8 5/8	6 13/16	8	6 5/8	7 1/4	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 5/8
September	8 3/16	8 1/4	7 1/4	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 1/4	7 5/8	7 1/8	7 5/8	7 1/4	7 3/4	7	7 1/2	7	7 1/4	7 1/4	7 3/8	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 5/8	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 5/8	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 3/4	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 1/2	7	6 1/2	7	6 5/8	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 5/8	7	6 7/8	7	6 7/8	7	7	7 3/16
April	7 5/16	7 5/8	6 15/16	7 9/16	6 15/16	7 5/8	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 5/8	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 5/8	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 3/8	7 11/16	7 1/4	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 1/2	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 1/8	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 1/2	5 3/8	5 3/4	5 1/8	5 5/16	5 1/8	5 5/16	5 3/16	5 1/2	5 5/8	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 1/8	5 1/2	5 1/2

Wholesale prices in leading cities of the United States, 1895-1899—Continued.

UPLAND MIDDLING COTTON (PER POUND)—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.
1898.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	$5\frac{7}{8}$	$5\frac{15}{16}$	$5\frac{3}{16}$	$5\frac{5}{8}$	$5\frac{5}{16}$	$5\frac{5}{8}$	$5\frac{7}{16}$	$5\frac{9}{16}$	$5\frac{1}{8}$	$5\frac{1}{4}$	$5\frac{3}{16}$	$5\frac{5}{16}$	$5\frac{3}{8}$	$5\frac{7}{16}$	$5\frac{7}{16}$	$5\frac{1}{2}$
February	$5\frac{15}{16}$	$6\frac{5}{16}$	$5\frac{1}{4}$	$5\frac{11}{16}$	$5\frac{5}{16}$	$5\frac{3}{4}$	$5\frac{1}{2}$	6	$5\frac{3}{16}$	$5\frac{15}{16}$	$5\frac{1}{4}$	$5\frac{3}{4}$	$5\frac{3}{8}$	$5\frac{3}{4}$	$5\frac{1}{2}$	$5\frac{15}{16}$
March	$6\frac{1}{16}$	$6\frac{5}{16}$	$5\frac{7}{16}$	$5\frac{3}{4}$	$5\frac{1}{2}$	$5\frac{13}{16}$	$5\frac{5}{8}$	$6\frac{1}{16}$	$5\frac{9}{16}$	$5\frac{3}{4}$	$5\frac{1}{2}$	$5\frac{3}{4}$	$5\frac{3}{4}$	6	$5\frac{3}{4}$	6
April	$6\frac{3}{16}$	$6\frac{3}{8}$	$5\frac{9}{16}$	$5\frac{13}{16}$	$5\frac{1}{2}$	6	$5\frac{3}{4}$	$5\frac{7}{8}$	$5\frac{9}{16}$	$5\frac{7}{8}$	$5\frac{9}{16}$	$5\frac{13}{16}$	$5\frac{5}{8}$	$6\frac{1}{4}$	$5\frac{13}{16}$	$6\frac{3}{16}$
May	$6\frac{5}{16}$	$6\frac{9}{16}$	$5\frac{11}{16}$	$6\frac{1}{16}$	$5\frac{5}{8}$	6	$5\frac{11}{16}$	6	$5\frac{11}{16}$	6	$5\frac{3}{4}$	$5\frac{3}{4}$	6	$6\frac{1}{4}$	$6\frac{1}{8}$	$6\frac{3}{8}$
June	$6\frac{5}{16}$	$6\frac{9}{16}$	$5\frac{15}{16}$	$6\frac{1}{16}$	$5\frac{7}{8}$	6	$5\frac{13}{16}$	6	$5\frac{3}{4}$	6	6	6	$5\frac{7}{8}$	$6\frac{1}{8}$	$6\frac{3}{16}$	$6\frac{3}{8}$
July	$6\frac{1}{16}$	$6\frac{1}{4}$	$5\frac{5}{8}$	$5\frac{15}{16}$	$5\frac{3}{4}$	$5\frac{7}{8}$	$5\frac{11}{16}$	$5\frac{13}{16}$	$5\frac{5}{8}$	$5\frac{3}{4}$	$5\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{5}{8}$	$5\frac{7}{8}$	$5\frac{7}{8}$	$6\frac{1}{8}$
August	$5\frac{3}{4}$	$6\frac{1}{4}$	$5\frac{3}{8}$	$5\frac{11}{16}$	$5\frac{3}{8}$	$5\frac{5}{8}$	$5\frac{7}{16}$	$5\frac{11}{16}$	$5\frac{1}{8}$	$5\frac{11}{16}$	5	$5\frac{1}{2}$	$5\frac{1}{4}$	$5\frac{5}{8}$	$5\frac{5}{8}$	$5\frac{7}{8}$
September	$5\frac{5}{16}$	$5\frac{13}{16}$	$4\frac{7}{8}$	$5\frac{3}{8}$	$4\frac{7}{8}$	$5\frac{5}{16}$	$4\frac{7}{8}$	$5\frac{7}{16}$	$4\frac{3}{4}$	$5\frac{3}{16}$	$4\frac{3}{4}$	$5\frac{1}{8}$	$4\frac{7}{8}$	$5\frac{1}{4}$	$5\frac{1}{8}$	$5\frac{5}{8}$
October	$5\frac{5}{16}$	$5\frac{1}{2}$	$4\frac{7}{8}$	$5\frac{1}{4}$	$4\frac{7}{8}$	5	$4\frac{7}{8}$	$5\frac{1}{16}$	$4\frac{5}{8}$	$4\frac{13}{16}$	$4\frac{11}{16}$	$4\frac{7}{8}$	$4\frac{7}{8}$	5	5	$5\frac{1}{8}$
November	$5\frac{5}{16}$	$5\frac{3}{4}$	$4\frac{3}{4}$	$5\frac{1}{16}$	$4\frac{7}{8}$	$5\frac{3}{16}$	$4\frac{7}{8}$	$5\frac{1}{4}$	$4\frac{1}{2}$	$4\frac{7}{8}$	$4\frac{9}{16}$	$4\frac{15}{16}$	$4\frac{3}{4}$	5	$4\frac{15}{16}$	$5\frac{1}{4}$
December	$5\frac{5}{8}$	$5\frac{7}{8}$	5	$5\frac{1}{4}$	$5\frac{1}{4}$	$5\frac{5}{8}$	$5\frac{1}{4}$	$5\frac{1}{2}$	$4\frac{7}{8}$	$5\frac{1}{8}$	$4\frac{15}{16}$	$5\frac{1}{4}$	5	$5\frac{3}{8}$	$5\frac{1}{4}$	$5\frac{7}{16}$
1899.																
January	$5\frac{7}{8}$	$6\frac{7}{16}$	$5\frac{3}{16}$	$5\frac{3}{4}$	$5\frac{5}{8}$	$5\frac{3}{4}$	$5\frac{7}{16}$	$6\frac{1}{16}$	$5\frac{1}{16}$	$5\frac{3}{4}$	$5\frac{1}{8}$	$5\frac{3}{4}$	$5\frac{3}{8}$	$5\frac{7}{8}$	$5\frac{3}{8}$	6
February	$6\frac{5}{16}$	$6\frac{3}{8}$	$5\frac{11}{16}$	6	$5\frac{11}{16}$	$6\frac{1}{4}$	6	$6\frac{3}{8}$	$5\frac{5}{8}$	$5\frac{15}{16}$	$5\frac{11}{16}$	$5\frac{15}{16}$	$5\frac{7}{8}$	6	6	$6\frac{1}{4}$
March	$6\frac{3}{16}$	$6\frac{9}{16}$	$5\frac{11}{16}$	$6\frac{1}{8}$	$5\frac{7}{8}$	$6\frac{1}{8}$	$5\frac{15}{16}$	$6\frac{1}{4}$	$5\frac{11}{16}$	$5\frac{7}{8}$	$5\frac{5}{8}$	$5\frac{15}{16}$	6	6	6	$6\frac{1}{8}$
April	$6\frac{1}{8}$	$6\frac{5}{16}$	$5\frac{5}{8}$	$5\frac{3}{4}$	$5\frac{3}{4}$	$5\frac{7}{8}$	$5\frac{7}{8}$	$5\frac{15}{16}$	$5\frac{5}{8}$	$5\frac{11}{16}$	$5\frac{1}{2}$	$5\frac{5}{8}$	$5\frac{7}{8}$	6	$5\frac{7}{8}$	6
May	$6\frac{1}{8}$	$6\frac{1}{4}$	$5\frac{11}{16}$	$5\frac{7}{8}$	$5\frac{3}{4}$	$5\frac{3}{4}$	$5\frac{7}{8}$	$5\frac{15}{16}$	$5\frac{5}{8}$	$5\frac{5}{8}$	$5\frac{1}{2}$	$5\frac{9}{16}$	$5\frac{7}{8}$	$5\frac{7}{8}$	$5\frac{7}{8}$	6
June	$6\frac{1}{16}$	$6\frac{5}{16}$	$5\frac{1}{2}$	$5\frac{7}{8}$	$5\frac{5}{8}$	$5\frac{13}{16}$	$5\frac{3}{4}$	$5\frac{15}{16}$	$5\frac{5}{8}$	$5\frac{5}{8}$	$6\frac{9}{16}$	$6\frac{5}{8}$	$5\frac{7}{8}$	$5\frac{7}{8}$	$5\frac{7}{8}$	$6\frac{1}{8}$
July	$6\frac{1}{8}$	$6\frac{1}{4}$	$5\frac{5}{8}$	$5\frac{7}{8}$	$5\frac{5}{8}$	$5\frac{7}{8}$	$5\frac{7}{8}$	$5\frac{7}{8}$	$5\frac{5}{8}$	$5\frac{5}{8}$	------	------	$5\frac{7}{8}$	$5\frac{7}{8}$	$5\frac{7}{8}$	6
August	$6\frac{1}{4}$	$6\frac{1}{2}$	$5\frac{3}{4}$	$5\frac{15}{16}$	$5\frac{3}{4}$	$5\frac{15}{16}$	$5\frac{7}{8}$	$6\frac{1}{8}$	$5\frac{1}{2}$	$5\frac{7}{8}$	$5\frac{1}{2}$	$5\frac{11}{16}$	$5\frac{7}{8}$	$5\frac{7}{8}$	$5\frac{15}{16}$	$6\frac{1}{8}$
September	$6\frac{1}{4}$	$6\frac{7}{8}$	$5\frac{3}{4}$	$6\frac{1}{2}$	$5\frac{7}{8}$	$6\frac{3}{4}$	$6\frac{1}{16}$	$6\frac{5}{8}$	$5\frac{5}{8}$	$6\frac{1}{2}$	$5\frac{1}{2}$	$6\frac{5}{8}$	$5\frac{7}{8}$	$6\frac{1}{2}$	6	$6\frac{7}{8}$
October	$7\frac{3}{16}$	$7\frac{3}{8}$	$6\frac{1}{2}$	$6\frac{15}{16}$	$6\frac{3}{4}$	$7\frac{1}{8}$	$6\frac{15}{16}$	$7\frac{1}{8}$	$6\frac{5}{8}$	$6\frac{7}{8}$	$6\frac{5}{8}$	7	$6\frac{1}{2}$	$7\frac{1}{4}$	$7\frac{1}{16}$	$7\frac{3}{16}$
November	$7\frac{3}{8}$	$7\frac{13}{16}$	$6\frac{7}{8}$	$7\frac{7}{16}$	7	$7\frac{1}{2}$	$7\frac{1}{16}$	$7\frac{1}{2}$	$6\frac{7}{8}$	$7\frac{1}{4}$	$6\frac{7}{8}$	$7\frac{3}{8}$	$7\frac{1}{8}$	$7\frac{1}{2}$	$7\frac{1}{16}$	$7\frac{1}{2}$
December	$7\frac{1}{2}$	$7\frac{3}{4}$	$7\frac{3}{16}$	$7\frac{1}{2}$	$7\frac{1}{4}$	$7\frac{7}{16}$	$7\frac{1}{4}$	$7\frac{7}{16}$	$7\frac{1}{8}$	$7\frac{5}{16}$	$7\frac{3}{16}$	$7\frac{3}{8}$	7	$7\frac{1}{4}$	$7\frac{5}{16}$	$7\frac{1}{2}$

Wholesale prices in leading cities of the United States, 1895–1899—Continued.

WOOL (PER POUND).

Date.	New York. XX Ohio. Low.	New York. XX Ohio. High.	Philadelphia. XX Ohio, washed. Low.	Philadelphia. XX Ohio, washed. High.	Chicago. Washed fleece, fine. Low.	Chicago. Washed fleece, fine. High.	St. Louis. Best tub-washed. Low.	St. Louis. Best tub-washed. High.
1895.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
January	17½	18	17	18	15	16	21	21
February	16½	17½	17	18	15	16	21	21
March	16½	16½	16	17	15	16	21	21
April	16	16½	16	17	14	15	20	21
May	16	16	16	17	14	15	19	20
June	16	16½	16	16½	14	15	19	20½
July	16½	18½	18	19	14	15	21	21
August	18½	18½	18	19	14	15	20	21
September	18½	18½	18	19	14	15	20	20½
October	18½	18⅞	18	19	15	17	20½	21
November	18⅞	18⅞	18	19	15	17	20	21
December	19	19	18	19	15	17	20	20½
1896.								
January	19	19	18	19	16	18	20	21
February	19	19	18	20	16	18	20	21
March	19	19	18	19	16	18	20	20½
April	18½	19	17½	18½	16	17	18	20
May	18½	18½	17	18	16	17	18	18
June	17½	17½	16	18	16	17	18	19
July	17½	17½	16½	18	14	16	17	18½
August	17½	17½	16	18	14	16	17	17½
September	17½	17½	16	18	14	16	17	18½
October	17½	17½	17½	18½	15	16	18	19
November	17½	17½	18½	19	15	16	20	21
December	17½	17½	19	21	15	16	20½	21
1897.								
January	17½	17½	19	20	15	16	20½	21
February	17½	17½	19	20	15	16	22	22
March	17½	17½	19	20	15	16	22	23
April	17½	18½	20	22	18	20	24	24½
May	18½	22	21	22	18	20	23	24
June	22	22	21	22	18	20	23	23½
July	22	21	22	23	22	26	24	24½
August	24	25½	23	25	22	26	25	28½
September	25½	28	25	27	22	26	28	32
October	28	30½	28	29	26	28	31	32
November	29	31½	29	31	26	28	30	31
December	29½	30	29	31	26	28	30	30
1898.								
January	30	31	29	30	25	26	30	30
February	30	31	30	31	25	26	29	30
March	30	31	29½	30½	25	26	28	29
April	30	31	28	30	24	28	27½	28
May	29	30	28	29	24	28	27	28
June	29	30	28	29	24	28	28	28
July	29	30	28	29	25	27	27½	28
August	29	30	28½	29½	25	27	27½	28
September	29	30	29	30	25	27	27	27
October	29	30	29	30	24	27	26	26½
November	28	29	28	29	24	27	25½	26
December	28	29	28	29	24	27	26	26
1899.								
January	28	29	27	28	20	21	26	26
February	28	29	26½	27	20	21	26	26
March	28	29	26½	27	20	21	25½	26
April	28	29	26	27	19	22	26	26
May	28	29	25½	26½	19	22	26	26½
June	28	29	27	28	19	22	27	27
July	28	29	28½	30	23	24	26	26½
August	30	32	29	31	23	24	26½	27
September	30	32	31	32	23	24	26½	27½
October	30	33	32½	33½	26	28	28	28½
November	32	36	33	34	26	28	29	32
December	36	39	35	36	26	28	34	35

Number and value of farm animals in the United States, 1880 to 1900.

[From Division of Statistics.]

January 1—	Horses.		Mules.		Milch Cows.	
	Number.	Value.	Number.	Value.	Number.	Value.
1880	11,201,800	$613,296,611	1,729,500	$105,948,319	12,027,000	$279,899,420
1881	11,429,626	667,954,325	1,720,731	120,096,164	12,368,653	296,277,060
1882	10,521,554	615,824,914	1,835,166	130,945,378	12,611,632	326,480,310
1883	10,838,111	765,041,308	1,871,079	148,732,390	13,125,685	396,575,405
1884	11,169,683	833,734,400	1,914,126	161,214,976	13,501,206	423,486,649
1885	11,564,572	852,282,947	1,972,569	162,497,097	13,904,722	412,903,093
1886	12,077,657	860,823,208	2,052,593	163,381,096	14,235,388	389,985,523
1887	12,496,744	901,685,755	2,117,141	167,057,538	14,522,083	378,789,589
1888	13,172,936	946,096,154	2,191,727	174,853,563	14,856,414	366,252,173
1889	13,663,294	982,194,827	2,257,574	179,444,481	15,298,625	366,226,376
1890	14,213,837	978,516,562	2,331,027	182,394,099	15,952,883	352,152,133
1891	14,056,750	941,823,222	2,296,532	178,847,370	16,019,591	346,397,900
1892	15,498,140	1,007,593,636	2,314,699	174,882,070	16,416,351	351,378,132
1893	16,206,802	992,225,185	2,331,128	164,763,751	16,424,087	357,299,785
1894	16,081,139	769,224,799	2,352,231	146,232,811	16,487,400	358,998,661
1895	15,893,318	576,730,580	2,333,108	110,927,834	16,504,629	362,601,729
1896	15,124,057	500,140,186	2,278,946	103,204,457	16,137,586	363,955,545
1897	14,364,667	452,649,396	2,215,654	92,302,090	15,941,727	369,239,993
1898	13,960,911	478,362,407	2,257,665	99,032,062	15,840,886	434,813,826
1899	13,665,307	511,074,813	2,134,213	95,963,261	15,990,115	474,233,925
1900	13,537,524	603,969,442	2,086,027	111,717,092	16,292,360	514,812,106

January 1—	Other cattle.		Sheep.		Swine.		Total value of farm animals.
	Number.	Value.	Number.	Value.	Number.	Value.	
1880	21,231,000	$341,761,154	40,765,900	$90,230,537	34,034,100	$145,781,515	$1,576,917,556
1881	20,937,702	362,861,509	43,576,899	104,070,759	36,247,603	170,535,435	1,721,795,252
1882	23,280,238	463,069,499	45,016,224	106,594,954	44,122,200	263,543,195	1,906,459,250
1883	28,046,077	611,549,109	49,237,291	124,365,835	43,270,086	291,951,221	2,338,215,268
1884	29,046,101	683,229,054	50,626,626	119,902,706	44,200,893	246,301,139	2,467,868,924
1885	29,866,573	694,382,913	50,360,243	107,960,650	45,142,657	226,401,683	2,456,428,380
1886	31,275,242	661,956,274	48,322,331	92,443,867	46,092,043	196,569,894	2,365,159,862
1887	33,511,750	663,137,926	44,759,314	89,872,839	44,612,836	200,043,291	2,400,586,938
1888	34,378,363	611,750,520	43,544,755	89,279,926	44,346,525	220,811,082	2,409,043,418
1889	35,032,417	597,236,812	42,599,079	90,640,369	50,301,592	291,307,193	2,507,050,058
1890	36,849,024	560,625,137	44,336,072	100,659,761	51,602,780	243,418,336	2,418,766,028
1891	36,875,648	544,127,908	43,431,136	108,397,447	50,625,106	210,193,923	2,329,787,770
1892	37,651,239	570,749,155	44,938,365	116,121,290	52,398,019	241,031,415	2,461,755,698
1893	35,954,196	547,882,204	47,273,553	125,909,264	46,094,807	295,426,492	2,483,506,681
1894	36,608,168	536,789,747	45,048,017	89,186,110	45,206,498	270,384,626	2,170,816,754
1895	34,364,216	482,999,129	42,294,064	66,685,767	44,165,716	219,501,267	1,819,446,306
1896	32,085,409	508,928,416	38,298,783	65,167,735	42,842,759	186,529,745	1,727,926,084
1897	30,508,408	507,929,421	36,818,643	67,020,942	40,600,276	166,272,770	1,655,414,612
1898	29,264,197	612,296,634	37,656,960	92,721,133	39,759,993	174,351,409	1,891,577,471
1899	27,994,225	637,931,135	39,114,453	107,697,530	38,651,631	170,109,743	1,997,010,407
1900	27,610,054	689,486,260	41,883,065	122,665,913	----------	----------	a2,042,650,813

a Exclusive of swine.

Average value of farm animals in the United States on January 1, 1880, to 1900.

[From Division of Statistics.]

Year.	Horses.	Mules.	Milch cows.	Other cattle.	Sheep.	Swine.
1880	$54.75	$61.26	$23.27	$16.10	$2.21	$4.28
1881	58.44	69.79	23.95	17.33	2.39	4.70
1882	58.53	71.35	25.89	19.89	2.37	5.97
1883	70.59	79.49	30.21	21.81	2.53	6.75
1884	74.64	84.22	31.37	23.52	2.37	5.57
1885	73.70	82.38	29.70	23.25	2.14	5.02
1886	71.27	79.60	27.40	21.17	1.91	4.26
1887	72.15	78.91	26.08	19.79	2.01	4.48
1888	71.82	79.78	24.65	17.79	2.05	4.98
1889	71.89	79.49	23.94	17.05	2.13	5.79
1890	68.84	78.25	22.14	15.21	2.27	4.72
1891	67.00	77.88	21.62	14.76	2.50	4.15
1892	65.01	75.55	21.40	15.16	2.58	4.60
1893	61.22	70.68	21.75	15.24	2.66	6.41
1894	47.83	62.17	21.77	14.66	1.98	5.98
1895	36.29	47.55	21.97	14.06	1.58	4.97
1896	33.07	45.29	22.55	15.86	1.70	4.35
1897	31.51	41.66	23.16	16.65	1.82	4.10
1898	34.26	43.88	27.45	20.92	2.46	4.39
1899	37.40	44.96	29.66	22.79	2.75	4.40
1900	44.61	53.56	31.60	24.97	2.93	----------

Number, average price, and total value of farm animals in the United States on January 1, 1900, by States.

States and Territories.	Horses.			Mules.		
	Number.	Average price per head.	Value.	Number.	Average price per head.	Value.
Maine	109,747	$58.62	$6,432,826	----	----	----
New Hampshire	55,578	57.89	3,217,455	----	----	----
Vermont	84,388	53.50	4,514,500	----	----	----
Massachusetts	66,017	78.07	5,154,136	----	----	----
Rhode Island	10,384	86.37	896,906	----	----	----
Connecticut	44,119	73.89	3,259,754	----	----	----
New York	590,771	63.06	37,251,355	3,714	$69.44	$257,903
New Jersey	79,972	72.88	5,828,258	7,196	94.48	679,883
Pennsylvania	559,722	59.39	33,243,571	37,794	76.16	2,878,355
Delaware	31,192	59.80	1,865,221	4,879	78.56	383,297
Maryland	130,959	53.07	6,950,014	12,891	72.69	937,005
Virginia	236,279	45.70	10,797,007	36,358	59.89	2,176,305
North Carolina	148,164	53.50	7,926,938	112,512	63.47	7,141,558
South Carolina	68,319	62.03	4,237,798	98,331	74.12	7,288,769
Georgia	109,935	54.59	6,001,626	157,008	68.95	10,826,032
Florida	38,050	46.70	1,776,778	8,521	71.60	610,096
Alabama	133,546	45.72	6,105,518	132,321	60.16	7,961,050
Mississippi	203,492	43.75	8,903,707	164,713	59.16	9,743,925
Louisiana	145,029	36.05	5,228,953	92,722	62.95	5,837,072
Texas	1,125,645	20.88	23,507,407	260,562	35.18	9,166,041
Arkansas	234,127	33.39	7,817,264	142,594	44.52	6,348,660
Tennessee	308,073	43.01	13,251,442	139,164	47.89	6,664,988
West Virginia	150,329	43.21	6,495,281	7,264	52.08	378,309
Kentucky	350,978	39.54	13,879,085	96,958	45.28	4,390,251
Ohio	640,429	55.00	35,222,931	16,883	58.04	979,911
Michigan	412,462	57.59	23,752,443	2,567	64.73	166,161
Indiana	577,220	50.83	29,337,792	38,734	55.28	2,141,258
Illinois	983,233	49.31	48,486,673	78,936	53.79	4,245,658
Wisconsin	418,018	61.53	25,722,329	4,611	63.79	294,128
Minnesota	459,673	54.95	25,256,763	8,248	59.39	489,858
Iowa	979,389	49.84	48,810,774	31,232	54.72	1,708,906
Missouri	724,597	34.35	24,891,718	165,026	43.69	7,210,321
Kansas	732,676	36.44	26,695,789	82,586	46.35	3,827,859
Nebraska	658,807	42.68	28,120,512	43,876	54.35	2,384,667
South Dakota	287,839	39.04	11,236,671	6,626	49.84	330,266
North Dakota	180,391	49.35	8,902,389	6,895	67.48	465,257
Montana	146,781	23.79	3,491,193	878	40.44	35,509
Wyoming	70,813	19.12	1,354,196	1,499	48.41	72,564
Colorado	145,713	27.92	4,068,081	8,580	46.60	399,827
New Mexico	83,184	20.21	1,680,945	3,298	34.06	112,323
Arizona	52,431	27.03	1,417,338	1,031	37.32	38,477
Utah	71,710	21.58	1,547,792	1,615	35.62	57,522
Nevada	42,090	16.41	690,594	1,338	34.87	46,654
Idaho	127,821	22.40	2,863,504	889	36.91	32,810
Washington	171,391	39.23	6,722,893	1,470	58.91	86,596
Oregon	183,986	29.99	5,516,923	5,441	38.64	210,241
California	321,729	38.61	12,422,429	48,682	48.49	2,360,713
Oklahoma	50,326	24.12	1,213,970	9,584	36.53	350,107
United States	13,537,524	44.61	603,969,442	2,086,027	53.56	111,717,092

Number, average price, and total value of farm animals in the United States on January 1, 1900, by States—Continued.

States and Territories.	Milch cows.			Other cattle.		
	Number.	Average price per head.	Value.	Number.	Average price per head.	Value.
Maine	203,814	$28.90	$5,890,225	112,723	$26.38	$2,973,863
New Hampshire	135,457	32.70	4,429,444	79,221	25.57	2,025,477
Vermont	268,886	31.90	8,577,463	132,450	23.41	3,100,074
Massachusetts	181,589	37.20	6,755,111	73,378	27.12	1,990,270
Rhode Island	25,256	39.95	1,008,977	10,149	29.83	302,788
Connecticut	144,529	34.80	5,029,609	66,188	30.90	2,045,545
New York	1,487,416	35.20	52,357,043	572,299	27.45	15,707,884
New Jersey	223,261	39.10	8,729,505	39,896	30.70	1,224,982
Pennsylvania	970,473	33.15	32,171,180	523,653	27.34	14,314,840
Delaware	35,730	31.50	1,125,495	22,305	28.03	625,247
Maryland	154,712	29.80	4,610,418	102,723	25.36	2,604,643
Virginia	242,488	24.05	5,831,836	325,000	23.96	7,787,812
North Carolina	243,298	18.20	4,428,024	274,843	12.31	3,383,726
South Carolina	122,959	19.25	2,366,961	137,264	10.77	1,478,267
Georgia	285,431	23.95	6,836,072	380,716	11.07	4,216,054
Florida	113,108	16.70	1,888,904	299,712	8.38	2,512,036
Alabama	231,802	18.40	4,265,157	279,278	10.96	3,061,719
Mississippi	244,103	20.70	5,052,932	273,706	13.59	3,719,121
Louisiana	123,232	21.95	2,704,942	171,729	13.37	2,296,702
Texas	693,794	25.25	17,518,298	4,352,541	17.86	77,736,384
Arkansas	188,936	20.25	3,825,954	230,486	14.04	3,235,910
Tennessee	239,394	24.15	5,781,365	286,841	18.79	5,390,598
West Virginia	167,173	28.40	4,747,713	241,025	25.15	6,061,432
Kentucky	235,798	27.25	6,425,496	303,651	24.52	7,446,740
Ohio	780,939	32.30	25,224,330	674,619	30.69	20,702,044
Michigan	463,698	32.70	15,162,925	338,120	26.75	9,043,695
Indiana	605,855	33.75	20,447,606	629,075	32.65	20,536,787
Illinois	1,021,236	36.30	37,070,867	1,303,018	31.62	41,197,518
Wisconsin	1,003,321	33.60	33,711,586	595,208	27.33	16,267,023
Minnesota	672,540	31.65	21,285,891	564,463	24.27	13,700,354
Iowa	1,263,283	34.90	44,088,577	2,178,729	33.47	72,930,788
Missouri	659,731	28.60	18,868,307	1,387,615	26.65	36,981,329
Kansas	707,675	32.50	22,999,438	2,159,549	28.90	62,401,253
Nebraska	685,338	35.50	24,329,499	1,521,454	30.38	46,220,249
South Dakota	398,383	33.40	13,305,992	480,817	29.61	14,237,235
North Dakota	176,205	31.95	5,629,750	255,166	27.24	6,951,242
Montana	45,314	39.25	1,778,574	914,494	27.19	24,865,089
Wyoming	18,104	40.55	734,117	729,722	28.10	20,505,914
Colorado	93,499	36.20	3,384,664	1,021,922	27.69	28,297,538
New Mexico	19,510	31.70	618,467	659,849	18.64	12,301,571
Arizona	19,140	32.50	622,050	362,721	16.46	5,969,293
Utah	57,209	32.75	1,873,595	278,867	22.93	6,396,237
Nevada	18,250	34.10	622,325	219,831	23.06	5,068,415
Idaho	33,075	31.90	1,055,092	364,853	23.77	8,672,748
Washington	122,414	35.40	4,333,456	268,030	25.21	6,757,573
Oregon	115,415	31.05	3,583,636	522,018	23.36	12,192,775
California	308,872	33.75	10,424,430	604,881	24.57	14,864,947
Oklahoma	40,715	31.90	1,298,808	283,256	25.36	7,182,529
United States	16,292,360	31.60	514,812,106	27,610,054	24.97	689,486,260

Number, average price, and total value of farm animals in the United States on January 1, 1900, by States—Continued.

SHEEP.

States and Territories.	Number.	Average price per head.	Value.
Maine	254,027	$3.10	$787,484
New Hampshire	79,072	3.19	252,239
Vermont	169,259	3.61	611,363
Massachusetts	40,194	4.55	182,883
Rhode Island	10,608	3.86	40,974
Connecticut	31,848	3.90	124,194
New York	846,165	4.07	3,448,122
New Jersey	42,722	4.34	185,584
Pennsylvania	814,322	3.60	2,928,302
Delaware	12,592	3.67	46,269
Maryland	138,177	3.51	485,553
Virginia	376,918	3.09	1,164,676
North Carolina	235,260	1.62	379,945
South Carolina	61,217	1.70	104,069
Georgia	294,826	1.76	518,893
Florida	76,074	1.69	128,870
Alabama	171,799	1.53	262,767
Mississippi	215,748	1.56	335,490
Louisiana	113,205	1.58	179,203
Texas	2,416,721	1.92	4,634,063
Arkansas	108,957	1.67	181,795
Tennessee	251,735	2.37	596,485
West Virginia	426,814	3.19	1,363,244
Kentucky	549,832	3.01	1,656,094
Ohio	2,839,690	3.71	10,535,250
Michigan	1,389,073	3.58	4,972,882
Indiana	677,905	4.00	2,713,993
Illinois	637,719	3.97	2,532,383
Wisconsin	744,656	3.65	2,716,505
Minnesota	419,218	3.18	1,333,113
Iowa	619,476	4.02	2,487,816
Missouri	597,619	3.10	1,854,711
Kansas	275,118	3.04	835,534
Nebraska	322,057	3.39	1,090,807
South Dakota	381,882	3.29	1,257,156
North Dakota	374,110	3.16	1,183,663
Montana	3,884,179	2.84	11,017,474
Wyoming	2,840,190	3.51	9,964,806
Colorado	2,185,327	2.86	6,250,036
New Mexico	3,973,439	2.17	8,622,362
Arizona	1,024,430	2.34	2,393,581
Utah	2,370,983	2.59	6,150,330
Nevada	657,773	2.91	1,914,120
Idaho	2,658,662	2.80	7,444,254
Washington	790,217	3.13	2,470,218
Oregon	2,446,695	2.67	6,532,676
California	2,001,501	2.85	5,710,282
Oklahoma	33,094	2.52	83,380
United States	41,883,065	2.93	122,665,913

IMPORTS AND EXPORTS OF AGRICULTURAL PRODUCTS.

[From Section of Foreign Markets.]

Agricultural imports of the United States during the five years ended June 30, 1899.

Articles imported.	1895.		1896.		1897.		1898.		1899.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
ANIMAL MATTER.										
Animals, live:										
Cattle ....number..	149,781	$765,853	217,826	$1,509,856	328,977	$2,589,857	291,589	$2,913,223	199,752	$2,330,362
Horses ....do....	13,098	1,055,191	9,991	662,591	6,998	464,808	3,085	414,899	3,042	551,050
Sheep ....do....	291,461	682,618	322,692	853,530	405,633	1,019,668	392,314	1,106,322	345,911	1,200,081
Other, including fowls	....	233,416	....	226,500	....	211,122	....	239,681	....	265,032
Total..........	....	2,737,078	....	3,252,477	....	4,285,455	....	4,674,125	....	4,336,525
Beeswax ....pounds..	288,001	78,776	273,464	75,970	174,017	43,339	272,097	72,473	452,016	109,957
Bones, hoofs, and horns:										
Bones, crude..........	....	306,049	....	157,946	....	224,039	....	492,544	....	704,959
Hoofs and horns..........	....	268,800	....	568,445	....	150,134				
Total..........	....	574,849	....	726,391	....	374,173	....	492,544	....	704,959
Bristles:										
Crude, not sorted, bunched, or prepared ....pounds..	4,741	1,892	726	1,620	630	385	1,203	416	21,421	12,399
Sorted, bunched, or prepared, pounds..........	1,296,753	1,242,259	1,571,804	1,433,728	1,347,270	1,216,794	1,533,887	1,248,703	1,835,156	1,445,853
Total ....pounds..	1,301,494	1,244,151	1,572,530	1,435,348	1,347,900	1,217,179	1,535,090	1,249,119	1,856,577	1,458,252
Dairy products:										
Butter..........do....	72,148	12,930	52,067	8,533	37,963	6,077	31,984	5,474	23,700	3,962
Cheese ....do....	10,276,293	1,450,657	10,728,397	1,491,338	12,319,122	1,668,796	10,012,188	1,343,173	11,826,175	1,563,128
Milk..........	....	80,491	....	62,622	....	58,467	....	67,729	....	52,603
Total..........	....	1,544,078	....	1,562,493	....	1,733,340	....	1,416,376	....	1,619,693
Eggs..........dozens..	2,705,502	324,136	947,182	88,682	580,631	47,760	166,319	8,078	225,180	21,300
Egg yolks..........	....	(a)	....	(a)	....	(a)	....	(a)	....	11,322
Feathers and downs, crude	....	1,746,967	....	2,386,804	....	2,232,908	....	2,238,955	....	1,768,092

Fibers, animal:										
Silk—										
Cocoons ....pounds	320,621	139,042	279,067	112,900	....	....	10,492	3,999	13,537	2,288
Raw, or as reeled from cocoon, pounds	7,974,810	22,029,068	8,000,621	26,246,902	6,513,612	18,496,944	10,315,162	31,446,800	9,691,145	31,827,061
Waste...................pounds.	1,021,029	457,946	1,084,299	403,626	1,479,832	421,339	1,762,297	659,267	1,545,701	650,278
Total silk ....do....	9,316,460	22,626,056	9,363,987	26,763,428	7,993,444	18,918,283	12,087,951	32,110,066	11,250,383	32,479,627
Wools, hair of the camel, goat, alpaca, and other like animals—										
Class 1, clothing—										
In the grease ....pounds..	87,151,522	13,335,602	117,233,440	19,448,471	176,350,510	27,824,507	43,061,372	7,302,841	12,973,444	1,948,402
Scoured ....do....					24,408,569	6,457,149	2,381,615	666,770	3,555	552
Total class 1 ....do....	87,151,522	13,335,602	117,233,440	19,448,471	200,759,079	34,281,656	45,442,987	7,969,611	12,976,999	1,948,954
Class 2, combing—										
In the grease ....do....	13,476,735	2,637,581	15,756,318	3,509,736	37,627,967	7,119,201	4,305,563	856,381	2,154,232	586,865
Scoured.................do....					323,523	68,419	15,310	3,218	1,187	196
Total class 2 ....do....	13,476,735	2,637,581	15,756,318	3,509,736	37,951,490	7,187,620	4,320,873	859,599	2,155,419	587,061
Class 3, carpet—										
In the grease ....do....	105,405,649	9,583,238	97,921,715	9,493,035	110,665,432	11,599,886	83,027,666	7,954,159	61,578,547	5,784,444
Scoured ....do....					1,476,025	174,029	3,676	323	25,244	2,438
Total class 3 ....do....	105,405,649	9,583,238	97,921,715	9,493,035	112,141,457	11,773,915	83,031,342	7,954,482	61,603,791	5,786,882
Total wools ....do....	206,033,906	25,556,421	230,911,473	32,451,242	350,852,026	53,243,191	132,795,202	16,783,692	76,736,209	8,322,897
Total animal fibers..............	....	48,182,477	....	59,214,670	....	72,161,474	....	48,893,758	....	40,802,524
Gelatin	....	(a)	....	15,386	....	5,748	....	25,907	....	21,961
Glue ....pounds..	4,751,048	416,304	6,276,926	555,979	4,926,620	472,312	4,103,814	428,507	5,358,083	479,450
Grease and tallow b........................	....	1,336,388	....	1,232,001	....	984,332	....	593,239	....	701,870
Gut	....	212,645	....	195,302	....	180,721	....	42,879	....	15,905
Hair......................................	....	1,165,944	....	1,241,077	....	1,330,632	....	1,839,068	....	1,814,964
Hide cuttings and other glue stock........	....	263,175	....	279,692	....	289,686	....	408,262	....	708,968
Hides and skins, c other than furs:										
Goatskins.....................pounds..	54,240,492	10,954,827	46,747,029	10,304,395	49,868,020	11,328,162	64,923,487	15,776,601	69,728,945	18,488,326
Hides of cattle d..................do....	172,335,253	15,168,115	163,650,982	20,215,782	156,232,824	16,534,864	126,243,595	13,624,989	130,396,020	13,621,946
Other..............................do....							54,607,534	7,667,342	66,965,785	9,877,771
Total ....do....	226,575,745	26,122,942	210,398,011	30,520,177	206,100,844	27,863,026	245,774,616	37,068,932	267,090,750	41,988,043
Honey...........................gallons..	67,444	22,993	79,985	30,609	66,432	27,599	96,604	38,158	126,217	51,599

a Not stated.
b Prior to August 27, 1894, and since July 24, 1897, tallow is included in "Other meat products" (dutiable).
c Except sheepskins with the wool on.
d Exclusive of hides of cattle from the Hawaiian Islands (free of duty).

Agricultural imports of the United States during the five years ended June 30, 1899—Continued.

Articles imported.	1895.		1896.		1897.		1898.		1899.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
ANIMAL MATTER—continued.										
Meat products:										
Meat and meat extracts		$479,336		$493,393		$601,808		$345,108		$263,845
Sausage, Bologna ......pounds..	(a)	93,188	359,260	80,887	328,080	76,303	(a)	82,546	(a)	93,714
Sausage casings		419,345		588,657		542,817		537,871		622,949
Other		5,244		39,129		49,484		80,031		109,647
Total		997,113		1,202,066		1,270,412		1,045,556		1,090,155
Oils, animal, not elsewhere specified, except whale and fish ......gallons..	1,464	469	37,330	12,213	38,334	6,066	14,163	5,715	9,056	1,569
Rennets		84,415		51,073		60,026		90,757		93,284
Stearin ......pounds..	(a)	(a)	523,341	37,020	(a)	(a)	(a)	(a)	1,865,977	25,546
Total animal matter		87,054,990		104,118,490		114,586,188		100,633,008		97,825,938
VEGETABLE MATTER.										
Argols, or wine lees ......pounds..	27,911,122	1,893,730	28,481,665	2,724,709	23,457,576	1,967,042	19,202,629	1,591,027	23,300,762	1,914,450
Breadstuffs:										
Barley ......bushels..	2,116,816	867,743	837,384	317,209	1,271,787	394,749	124,804	43,863	110,475	53,696
Corn (maize) ......do....	16,575	7,552	4,338	1,877	6,284	2,070	3,417	1,479	4,171	1,618
Oats ......do....	308,308	80,901	47,506	13,039	46,459	12,071	9,098	3,368	11,500	4,432
Oatmeal ......pounds..	396,176	21,993	343,732	19,689	1,525,409	32,742	287,910	15,697	298,764	17,740
Rye ......bushels..	12,918	6,272	154	291	72	170	32,938	13,323	402	982
Wheat ......do....	1,429,993	868,965	2,110,030	1,386,161	1,534,117	1,176,337	2,046,590	1,948,289	1,871,101	1,407,625
Wheat flour ......barrels..	1,868	8,295	1,394	6,848	2,250	9,914	2,744	12,230	905	4,057
Other, and preparations of, used as food		998,092		1,035,700		1,146,710		1,113,818		1,054,615
Total		2,859,813		2,780,814		2,774,763		3,152,067		2,544,765
Chocolate, other than confectionery and sweetened chocolate ......pounds..	897,637	174,805	1,145,467	198,417	1,467,977	239,819	992,288	149,866	1,124,515	201,439
Cocoa, or cacao:										
Crude, and leaves and shells of..do....	29,307,048	3,195,811	23,276,597	2,387,078	31,406,612	2,997,866	25,717,404	3,492,033	35,512,364	5,064,703
Prepared or manufactured ....do....	1,433,576	482,532	1,244,309	410,249	1,495,459	443,604	815,824	290,844	926,219	295,413
Total ......do....	30,740,624	3,678,343	24,520,906	2,797,327	32,902,071	3,441,470	26,533,228	3,782,877	36,438,583	5,360,116
Coffee ......do....	652,208,975	96,130,717	580,597,915	84,793,124	737,645,670	81,544,384	870,514,455	65,067,631	831,827,063	55,275,470

Coffee substitutes:										
Chicory root—										
Raw, unground ....pounds..	9,544,186	158,142	15,841,955	210,228	16,930,162	232,494	315,707	5,100	159,269	2,353
Roasted, ground, or otherwise prepared ....pounds..	445,458	14,816	475,933	15,849	399,008	13,899	(a)	(a)	335,347	11,061
Total chicory root ....do....	9,989,644	172,958	16,317,888	226,077	17,329,170	246,393	(a)	(a)	494,616	13,414
Other.........................do....	2,776,117	106,886	2,366,962	90,532	2,373,245	87,679	857,810	29,562	992,395	36,370
Total coffee substitutes ..do....	12,765,761	279,844	18,684,850	316,609	19,702,415	334,072	(a)	(a)	1,487,011	49,784
Curry and curry powder	....	(a)	....	(a)	....	(a)	....	(a)	....	7,383
Fibers, vegetable:										
Cotton ....pounds..	49,332,022	4,714,375	55,350,520	6,578,212	51,898,926	5,884,262	52,660,363	5,019,503	50,158,158	5,013,146
Flax, and tow of ....tons..	5,008	1,008,743	6,538	1,171,663	7,480	1,256,717	5,529	1,193,597	6,474	1,306,520
Flax, hackled, etc ....do....	2,225	1,050,548	1,295	632,765	1,710	641,259				
Hemp, and tow of...............do....	6,177	754,975	8,356	1,046,656	5,096	633,288	4,017	560,334	3,941	477,108
Hemp, hackled, etc..............do....	777	127,786	94	22,847	21	6,569				
Istle, or Tampico fiber ....do....	9,827	458,404	12,207	717,585	6,313	335,841	2,563	130,294	4,419	284,177
Jute and jute butts..............do....	110,671	2,752,966	88,992	2,001,266	68,550	1,640,484	112,306	2,543,498	83,161	2,296,189
Manila hemp.....................do....	50,278	4,060,517	47,244	3,604,585	46,260	3,408,322	50,270	3,239,341	53,195	6,211,475
Sisal grass.......................do....	47,596	2,743,396	52,130	3,412,760	63,266	3,834,732	69,322	5,169,900	71,898	9,211,377
Other.............................do....	6,152	324,746	6,336	260,627	8,734	579,206	9,791	609,222	7,466	513,247
Total..................................	....	17,996,456	....	19,448,906	....	18,220,680	....	18,465,689	....	25,313,239
Flowers, natural, dressed or undressed b.	....	10,014	....	10,386	....	10,334	....	11,914	....	19,392
Fruit juices:										
Prune juice or prune wine..gallons..	39,011	28,826	34,422	28,566	34,546	24,222	26,174	23,285	35,047	27,204
Other, including cherry juice..do....	(a)	26,470	(a)	47,285	(a)	56,767	52,968	25,879	44,841	23,173
Total ....do....	(a)	55,296	(a)	75,851	(a)	80,989	79,142	49,164	79,888	50,377
Fruits and nuts:										
Fruits—										
Bananas	....	4,674,861	....	4,502,746	....	4,086,320	....	4,236,418	....	5,665,588
Currants.................pounds..	16,450,706	258,659	33,040,846	551,072	29,265,761	596,084	25,186,210	837,987	30,849,253	798,357
Dates.......................do....	15,186,789	316,592	13,680,302	273,456	11,847,279	284,056	13,561,434	371,992	12,943,305	324,087
Figs ....do....	11,855,890	587,420	11,900,710	639,512	8,940,762	535,380	9,628,426	509,002	7,284,058	356,762
Lemons	....	3,917,326	....	5,040,344	....	4,043,822	....	2,848,130	....	4,398,004
Oranges................................	....	1,997,266	....	2,694,131	....	2,324,907	....	886,722	....	1,097,596
Plums and prunes.......pounds..	14,352,057	527,625	483,658	68,862	710,028	73,303	303,992	39,660	600,360	63,574
Raisins ....do....	15,921,278	651,420	10,826,094	460,200	12,650,598	567,039	6,593,833	381,889	4,933,201	282,400

a Not stated.

b Prior to July 24, 1897, exclusive of natural flowers free of duty.

Agricultural imports of the United States during the five years ended June 30, 1899—Continued.

Articles imported.	1895.		1896.		1897.		1898.		1899.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
VEGETABLE MATTER—continued.										
Fruits and nuts—Continued.										
Fruits—Continued.										
Prepared or preserved fruits		$570,568		$598,928		$605,053		$922,357		$1,020,644
Other *a*		1,725,342		2,128,056		1,810,807		1,294,855		1,579,652
Total fruits *a*		15,227,079		16,957,307		14,926,771		12,329,012		15,586,664
Nuts—										
Almonds ...pounds	7,903,375	810,439	7,789,681	763,594	9,644,338	880,263	5,746,362	659,659	9,957,427	1,222,587
Cocoanuts		471,994		442,739		471,387		575,935		625,789
Other *b*		730,411		868,799		848,511		1,002,344		879,166
Total nuts *b*		2,012,844		2,075,132		2,200,161		2,237,938		2,727,542
Total fruits and nuts		17,239,923		19,032,439		17,126,932		14,566,950		18,314,206
Ginger, preserved or pickled ...pounds	(*c*)	15,395	(*c*)	23,547	(*c*)	7,123	(*c*)	14,295	142,698	6,309
Hay ...tons	201,900	1,423,716	302,652	2,773,535	119,942	1,030,497	3,887	34,659	19,872	115,499
Hops ...pounds	3,133,664	599,744	2,772,045	600,419	3,017,821	629,987	2,375,922	648,155	1,319,319	591,755
Indigo ...do	3,956,986	2,015,975	3,340,001	1,673,170	3,522,016	1,696,641	3,097,340	1,815,411	3,127,357	1,698,583
Malt, barley ...bushels	11,069	7,495	5,579	4,774	11,084	9,384	4,769	4,412	4,984	4,447
Malt extract, fluid or solid		51,501		23,889		11,485		6,917		5,320
Malt liquors:										
Bottled ...gallons	943,939	900,037	1,038,641	1,007,146	1,048,994	1,025,867	733,535	695,102	918,562	917,186
Unbottled ...do	2,027,737	614,808	2,244,763	657,870	1,915,650	534,426	1,777,202	506,428	1,928,672	570,692
Total ...do	2,971,676	1,514,845	3,283,404	1,665,016	2,964,644	1,560,293	2,510,737	1,201,530	2,847,234	1,487,878
Nursery stock (plants, trees, shrubs, vines, etc.) *d*		632,523		955,307		963,977		762,158		768,982
Oil cake ...pounds	6,794,531	47,774	7,473,016	45,725	3,098,364	20,313	2,159,809	8,799	1,885,648	9,553
Oil cake (substitute for india rubber)		(*c*)		(*c*)		(*c*)		(*c*)		1,149
Oils, vegetable:										
Fixed or expressed—										
Olive, salad ...gallons	775,046	952,405	942,598	1,167,049	928,567	1,134,077	736,877	923,804	930,042	1,090,250
Other		2,570,035		2,557,026		2,353,084		2,434,209		2,519,157
Volatile, or essential		1,398,956		1,554,289		1,885,523		1,511,078		1,691,257
Total		4,921,396		5,278,364		5,372,684		4,869,091		5,300,664

Opium:										
Crude or unmanufactured..pounds..	358,455	730,669	365,514	683,347	1,072,914	2,184,727	123,845	265,607	513,499	1,223,951
Prepared.......................do....	139,765	920,006	98,745	735,134	157,061	1,132,861	100,258	652,341	124,214	828,203
Total.......................do....	498,220	1,650,675	464,259	1,418,481	1,229,975	3,317,588	224,103	917,948	637,713	2,052,154
Rice and rice meal:										
Rice...........................pounds..	141,301,411	2,353,974	78,190,334	1,274,574	133,939,930	2,555,960	129,810,630	2,793,111	153,837,026	3,152,771
Rice flour, rice meal, and broken rice, pounds..............................	78,262,909	1,091,538	68,534,273	911,005	63,876,204	961,200	60,474,685	953,722	50,340,267	777,378
Total.................pounds..	219,564,320	3,445,512	146,724,607	2,185,579	197,816,134	3,517,160	190,285,315	3,746,833	204,177,293	3,930,149
Sauerkraut................................	....	25,898	....	7,895	....	1,831	....	(c)	....	(c)
Seeds:										
Linseed, or flaxseed.........bushels..	4,166,222	4,554,484	754,507	812,940	105,222	108,871	136,098	150,515	81,953	87,602
Other......................................	....	1,981,096	....	1,870,214	....	1,315,055	....	1,081,251	....	1,134,243
Total......................................	....	6,535,580	....	2,683,154	....	1,423,926	....	1,231,766	....	1,221,845
Spices:										
Unground—										
Nutmegs...................pounds..	1,652,613	513,801	1,355,420	433,436	1,669,740	451,614	1,213,994	331,235	1,530,102	368,765
Pepper, black or white.....do....	20,501,837	791,343	16,644,763	650,861	15,033,452	711,453	14,080,136	909,711	12,352,747	1,083,100
Other (free of duty)........do....	17,879,564	1,062,868	19,193,589	999,226	20,411,490	1,076,963	13,784,689	898,992	13,851,055	997,783
Ground (and other dutiable)..do....	2,058,782	272,223	2,618,214	294,996	3,030,031	336,686	2,658,706	264,691	3,346,925	332,653
Total.......................do....	42,092,796	2,640,235	39,811,986	2,378,519	40,144,713	2,576,716	31,737,525	2,404,629	31,080,829	2,782,301
Spirits, distilled:										
Of domestic manufacture, returned, proof gallons..............................	770,124	670,292	1,029,653	940,060	956,760	863,558	854,586	734,901	998,173	834,948
Brandy...................proof gallons..	313,327	813,882	259,704	690,761	337,595	911,721	137,902	395,758	219,968	626,875
Other.............................do....	1,139,710	1,246,567	1,249,895	1,446,873	1,727,110	2,074,835	770,830	1,004,135	1,227,834	1,683,256
Total.......................do....	2,223,161	2,730,741	2,539,252	3,077,694	3,021,465	3,850,114	1,763,318	2,134,794	2,445,975	3,145,079
Starch..............................pounds..	4,265,650	82,150	3,467,309	62,756	2,941,253	51,812	6,120,924	103,780	8,542,897	140,528
Straw.................................tons..	7,745	24,544	7,879	31,140	9,386	31,768	1,448	4,463	2,075	4,564
Sugar and molasses:										
Molasses.......................gallons..	15,075,879	1,295,146	4,687,664	737,265	3,702,471	586,513	3,603,547	544,016	5,821,556	789,576
Sugar—										
Not above No. 16 Dutch standard—										
Beet sugar...............pounds..	347,376,732	6,993,282	604,686,985	14,048,914	1,865,577,495	33,689,158	140,641,485	2,717,955	723,356,352	15,269,397
Other........................do....	3,168,781,436	67,836,512	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
Above No. 16 Dutch standard, pounds..............................	58,352,286	1,633,042	187,463,791	5,353,573	199,136,169	4,928,150	101,088,663	2,434,921	62,745,763	1,692,951
Total sugar.............pounds..	3,574,510,454	76,462,836	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
Total sugar and molasses........	....	77,757,982	....	89,957,038	....	99,652,694	....	61,016,765	....	95,753,696
Tea..................................pounds..	97,253,458	13,171,379	93,998,372	12,704,440	113,347,175	14,835,862	71,957,715	10,054,283	74,089,899	9,675,081

a Including nuts free of duty, except cocoanuts.
b Exclusive of nuts free of duty, except cocoanuts.
c Not stated.
d Apparently including natural flowers free of duty from August 27, 1894, to July 24, 1897.

Agricultural imports of the United States during the five years ended June 30, 1899—Continued.

Articles imported.	1895.		1896.		1897.		1898.		1899.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
VEGETABLE MATTER—continued.										
Tobacco, leaf:										
Suitable for cigar wrappers..pounds..	5,679,252	$7,219,877	5,211,852	$5,596,778	6,057,268	$5,663,214	3,988,561	$3,913,294	4,147,048	$4,349,034
Other (including stems)........do....	20,989,009	7,525,843	27,713,114	10,906,352	7,747,959	3,920,941	6,488,547	3,575,314	9,888,781	5,551,219
Total..................do....	26,668,261	14,745,720	32,924,966	16,503,130	13,805,227	9,584,155	10,477,108	7,488,608	14,035,829	9,900,253
Vanilla beans..................do....	137,296	495,273	235,763	1,013,608	165,001	884,865	63,997	279,755	272,174	1,235,412
Vegetables:										
Beans and peas..........bushels..	1,535,960	1,548,767	613,801	658,320	482,984	489,274	163,560	149,227	184,499	165,850
Cabbages..................number..	(a)	(a)	1,261,696	55,644	711,033	38,906	....	(a)	....	(a)
Onions....................bushels..	(a)	(a)	(a)	(a)	560,138	627,273	488,853	429,173	771,960	499,530
Potatoes..................do....	1,341,533	603,554	175,240	127,595	246,178	145,584	1,171,378	473,154	530,420	294,391
Pickles and sauces..................	....	321,632	....	324,377	....	332,243	....	243,354	....	352,022
Other—										
In their natural state..............	....	679,894	....	683,117	....	256,752	....	239,733	....	312,673
Prepared or preserved..............	....	817,689	....	727,797	....	720,822	....	499,959	....	554,302
Total vegetables..............	....	3,971,536	....	2,576,850	....	2,610,854	....	2,034,600	....	2,178,738
Vinegar....................gallons..	75,108	19,823	81,075	24,552	76,123	20,519	85,556	22,313	93,443	23,534
Wafers, unmedicated..................	....	21,105	....	16,748	....	20,082	....	11,797	....	14,733
Wines:										
Champagne and other sparking, dozen bottles..................	257,757	3,807,961	246,393	3,628,319	228,628	3,348,004	223,827	3,264,323	262,371	3,668,791
Still wines—										
Bottled..........dozen bottles..	296,779	1,430,229	314,190	1,527,916	309,281	1,475,211	268,921	1,312,147	274,873	1,347,842
Unbottled..............gallons..	2,789,153	1,945,347	2,834,898	1,950,770	2,997,952	2,039,250	1,930,870	1,392,710	2,253,226	1,573,573
Total..................	....	7,183,537	....	7,107,005	....	6,862,465	....	5,969,180	....	6,590,206
Total vegetable matter..........	....	286,060,995	....	286,910,917	....	286,285,280	....	213,658,788	....	257,688,943
Total agricultural imports..........	....	373,115,985	....	391,029,407	....	400,871,468	....	314,291,796	....	355,514,881

a Not stated.

Agricultural exports (domestic) of the United States during the five years ended June 30, 1899.

Articles exported.	1895.		1896.		1897.		1898.		1899.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
ANIMAL MATTER.										
Animals, live:										
Cattle ....number	331,722	$30,603,796	372,461	$34,560,672	392,190	$36,357,451	439,255	$37,827,500	389,490	$30,516,833
Hogs ....do	7,130	72,424	21,049	227,297	28,751	295,998	14,411	110,487	33,031	227,241
Horses ....do	13,984	2,209,298	25,126	3,530,703	39,532	4,769,265	51,150	6,176,569	45,778	5,444,342
Mules ....do	2,515	186,452	5,918	406,161	7,473	545,331	8,098	664,789	6,755	516,908
Sheep ....do	405,748	2,630,686	491,565	3,076,384	244,120	1,531,645	199,690	1,213,886	143,286	853,555
Other, including fowls	....	51,389	....	39,752	....	68,771	....	250,175	....	322,037
Total	....	35,754,045	....	41,840,969	....	43,568,461	....	46,243,406	....	37,880,916
Beeswax ....pounds	309,212	90,875	222,612	65,844	195,048	56,462	151,094	41,827	152,494	41,916
Bones, hoofs, horns and horn tips, strips, and waste	....	288,084	....	321,680	....	280,140	....	174,861	....	195,759
Bristles	....	3,901	....	(a)	....	415	....	(a)	....	(a)
Dairy products:										
Butter ....pounds	5,598,812	915,533	19,373,913	2,937,203	31,345,224	4,493,364	25,690,025	3,864,765	20,247,997	3,263,951
Cheese ....do	60,448,421	5,497,539	36,777,291	3,091,914	50,944,617	4,636,063	53,167,280	4,559,324	38,198,753	3,316,049
Milk	....	219,785	....	270,453	....	524,968	....	671,670	....	1,049,211
Total	....	6,632,857	....	6,299,570	....	9,654,395	....	9,095,759	....	7,629,211
Eggs ....dozens	151,007	25,317	328,485	48,339	1,300,183	180,954	2,754,810	448,370	3,693,611	641,385
Egg yolks	....	2,255	....	556	....	(a)	....	(a)	....	10,379
Feathers:										
Ostrich	....	9	....	250	....	5,679	(a)	157,553	(a)	212,374
Other ....pounds	b 1,284,895	b 215,681	1,165,658	193,046	1,142,632	112,714				
Total	....	215,690	....	193,296	....	118,393	....	157,553	....	212,374
Fertilizer (refuse skins)	....	(a)	....	(a)	....	(a)	....	(a)	....	1,062
Glue ....pounds	1,178,328	114,493	1,760,470	166,930	1,400,863	132,581	2,318,711	209,441	2,368,087	222,072
Grease, grease scraps, and other soap stock	....	904,071	....	1,516,763	....	2,070,111	....	1,964,565	....	2,576,507
Hair (including manufactures of)	....	505,029	....	455,880	....	517,469	....	635,716	....	503,712
Hides and skins, other than furs. pounds	36,002,859	2,310,323	39,545,324	3,858,946	31,119,166	2,388,530	11,536,073	1,015,032	10,140,840	929,117
Honey	....	118,873	....	90,969	....	22,368	....	98,504	....	55,900

a Not stated.

b Exclusive of egret feathers.

Agricultural exports (domestic) of the United States during the five years ended June 30, 1899—Continued.

Articles exported.	1895.		1896.		1897.		1898.		1899.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
ANIMAL MATTER—continued.										
Meat products:										
Beef products—										
Beef, canned ....pounds..	64,102,263	$5,720,933	63,698,180	$5,636,953	54,019,772	$4,656,308	37,109,570	$3,279,657	38,385,472	$3,503,393
Beef, fresh ....do....	191,338,487	16,832,860	224,783,225	18,974,107	290,395,920	22,653,742	274,768,074	22,966,556	282,139,974	23,545,185
Beef, salted or pickled......do....	62,473,325	3,558,230	70,709,209	3,975,113	67,712,940	3,514,136	44,314,479	2,363,467	46,564,876	2,525,784
Beef, other cured ....do....	821,673	73,509	514,303	59,371	939,448	83,701	1,580,052	150,051	1,579,313	145,996
Tallow ....do....	25,864,300	1,293,059	52,759,212	2,323,764	75,103,834	2,782,595	81,744,809	3,141,653	107,361,009	4,367,356
Total beef products. .....do....	344,600,048	27,478,651	412,464,129	30,969,308	488,176,924	33,690,472	439,525,984	31,906,384	476,030,644	34,087,614
Hog products—										
Bacon ....do....	452,549,976	37,776,293	425,352,187	33,442,847	500,399,448	34,187,147	650,108,933	46,380,918	562,651,480	41,557,067
Hams.........................do....	105,494,123	10,960,567	129,036,351	12,669,763	165,247,302	15,970,021	200,185,861	18,987,525	225,846,750	20,774,084
Pork, fresh...................do....	818,581	60,660	744,656	43,739	1,306,424	94,816	12,224,285	815,075	41,310,364	2,722,661
Pork, salted or pickled .....do....	58,266,893	4,138,400	69,498,373	3,973,461	66,768,920	3,297,214	88,133,078	4,906,961	137,197,200	7,917,066
Lard ....do....	474,895,274	36,821,508	509,534,256	33,589,851	568,315,640	29,126,485	709,344,045	39,710,672	711,259,851	42,208,465
Total hog products.......do....	1,092,024,847	89,757,428	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
Mutton.........................do....	591,449	47,832	422,950	31,793	361,955	28,341	329,169	27,961	379,110	29,427
Oleo and oleomargarin—										
Oleo-oil......................do....	78,098,878	7,107,018	103,276,756	8,087,905	113,506,152	6,742,061	132,579,277	7,904,413	142,390,492	9,183,659
Oleomargarin (imitation butter), pounds..........................	10,100,897	992,464	6,063,699	587,269	4,864,351	472,856	4,328,536	386,297	5,549,322	509,703
Total oleo and oleomargarin, pounds..........................	88,199,775	8,099,482	109,340,455	8,675,174	118,370,503	7,214,917	136,907,813	8,290,710	147,939,814	9,693,362
Poultry and game....................	....	17,898	....	40,647	....	72,082	....	85,739	....	183,503
Sausage casings.....................	....	1,581,891	....	1,771,680	....	1,514,651	....	1,821,519	....	1,671,052
Other meat products	....	1,600,231	....	1,767,437	....	2,944,486	....	4,193,078	....	5,834,865
Total meat products............	....	128,583,413	....	126,975,700	....	128,140,632	....	157,126,542	....	166,679,166
Oils, animal, not elsewhere specified:										
Lard oil ....gallons..	553,421	304,093	833,935	426,401	961,407	419,803	775,102	305,825	917,007	412,447
Other, except whale and fish...do....	144,556	75,585	100,934	50,839	112,555	47,836	123,711	50,587	166,372	64,368
Total ....do....	697,977	379,678	934,869	477,240	1,073,962	467,639	898,813	356,412	1,083,379	476,815

Quills		13,653		27,920		19,264		14,413		12,213
Rennets, prepared		1,801		517		735		(a)		(a)
Silk noils		(a)		1,978		(a)		(a)		(a)
Silk waste ... pounds	65,673	23,391	102,624	31,163	54,060	13,181	153,856	19,002	123,693	16,075
Silkworm eggs		2,859		25		25		(a)		(a)
Stearin ... pounds	36,429	2,157	665,585	34,289	1,583,555	70,534	3,987,258	188,579	1,174,167	55,821
Wool ... do	4,279,109	484,463	6,945,981	855,950	5,271,535	619,932	121,139	18,071	1,683,419	237,390
Total animal matter		176,457,219		183,264,812		188,322,221		217,808,053		218,377,750
VEGETABLE MATTER.										
Breadstuffs:										
Barley ... bushels	1,563,754	767,228	7,680,331	3,100,311	20,030,301	7,646,384	11,237,677	5,542,040	2,267,403	1,375,274
Bran, middlings, and mill feed ... tons	(a)	(a)	(a)	(a)	(a)	(a)	91,189	1,329,519	127,953	2,602,588
Bread and biscuit ... pounds	14,206,314	634,600	15,426,601	694,323	15,214,619	697,695	15,990,558	788,264	16,447,430	809,998
Buckwheat ... bushels	(a)	(a)	(a)	(a)	1,677,102	678,959	1,370,403	589,285	1,533,950	846,028
Corn (maize) ... do	27,691,137	14,650,767	99,992,835	37,836,862	176,916,305	54,087,152	208,744,939	74,196,850	174,080,094	68,977,448
Corn meal ... barrels	223,567	648,844	276,885	654,121	475,263	902,061	827,651	1,766,068	791,488	1,775,868
Oats ... bushels	569,977	200,793	13,012,590	3,497,611	35,096,736	8,756,257	69,130,288	20,632,914	30,309,778	9,787,540
Oatmeal ... pounds	20,499,253	566,321	38,592,504	939,502	47,310,251	1,071,340	85,500,350	1,757,978	58,042,505	1,295,988
Rye ... bushels	9,437	5,340	988,466	445,075	8,560,271	3,667,505	15,541,575	8,825,769	10,140,866	5,936,078
Rye flour ... barrels	3,768	12,062	3,777	11,163	2,566	7,366	3,410	11,815	4,826	15,015
Wheat ... bushels	76,102,704	43,805,663	60,650,080	29,760,868	79,562,020	59,920,178	148,231,261	145,684,659	139,432,815	104,269,169
Wheat flour ... barrels	15,268,892	51,651,928	14,620,864	52,025,217	14,569,545	55,914,347	15,349,943	69,263,718	18,485,690	73,093,870
Preparations of, for table food		1,661,234		2,442,940		4,508,025		1,705,207		2,133,110
Other								1,743,033		1,681,725
Total		114,604,780		141,356,993		197,857,219		333,897,119		273,999,699
Broom corn		169,503		181,853		136,007		163,066		185,902
Broom root (rice root)		(a)		(a)		(a)		(a)		19,975
Cider ... gallons	669,745	85,675	372,986	47,670	637,672	77,695	465,873	60,063	490,803	64,500
Coffee and cocoa, ground or prepared, and chocolate		104,317		107,740		128,078		137,369		192,863
Cotton:										
In bales—b										
Sea-island ... bales	39,333	2,782,639	49,651	3,816,216	55,347	4,078,044	40,037	2,767,291	36,213	2,361,697
Sea-island ... pounds	15,261,322		19,159,469		21,585,360		15,610,302		14,142,052	
Other ... bales	6,926,025	202,118,351	4,610,114	186,240,244	6,121,018	226,812,927	7,540,967	227,674,924	7,337,169	207,203,077
Other ... pounds	3,502,171,787		2,316,066,916		3,082,169,589		3,834,653,993		3,759,268,241	
Total in bales ... bales	6,965,358	204,900,990	4,659,765	190,056,460	6,176,365	230,890,971	7,581,004	230,442,215	7,373,382	209,564,774
Total in bales ... pounds	3,517,433,109		2,335,226,385		3,103,754,949		3,850,264,295		3,773,410,293	
Waste cotton ... pounds	(a)	(a)	(a)	(a)	(a)	(a)	12,521,574	511,004	14,308,829	524,802
Total cotton ... pounds	3,517,433,109	204,900,990	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
Cotton-seed hulls		235		(a)		(a)		(a)		(a)

a Not stated.

b Probably including waste cotton prior to 1898.

Agricultural exports (domestic) of the United States during the five years ended June 30, 1899—Continued.

Articles exported.	1895.		1896.		1897.		1898.		1899.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
VEGETABLE MATTER—continued.										
Cotton-seed meats		(*a*)		(*a*)		$37,970		(*a*)		(*a*)
Flax		$906		(*a*)		(*a*)		(*a*)		(*a*)
Flowers, cut		2,521		$798		1,429		$2,967		$2,355
Fruits and nuts:										
Fruits—										
Apples, dried ...pounds	7,085,946	461,214	26,691,963	1,340,507	30,775,401	1,340,159	31,031,254	1,897,725	19,305,739	1,245,733
Apples, green or ripe ...barrels	818,711	1,954,318	360,002	930,289	1,503,981	2,371,143	605,390	1,684,717	380,222	1,210,459
Oranges		(*a*)		(*a*)		(*a*)		339,396		282,313
Prunes ...pounds	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	15,940,791	1,021,888	5,615,565	380,847
Raisins ...do	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	(*a*)	3,109,639	167,062	4,659,807	242,620
Other green, ripe, or dried		1,522,100		1,868,353		2,172,199		2,033,845		1,997,649
Preserved—										
Canned		871,465		1,376,281		1,686,723		1,624,741		2,330,715
Other		47,420		70,353		43,276		82,504		66,899
Total fruits		4,856,517		5,585,783		7,613,500		8,851,878		7,757,235
Nuts		115,274		93,283		125,805		161,432		140,250
Total fruits and nuts		4,971,791		5,679,066		7,739,305		9,013,310		7,897,485
Ginseng ...pounds	233,236	826,713	199,436	770,673	179,573	840,686	174,063	638,446	190,196	782,545
Glucose, or grape sugar ...do	133,808,329	2,567,784	171,231,650	2,772,335	194,419,250	2,736,674	196,864,605	2,871,839	229,003,571	3,624,890
Grasses, dried		19,781		44,583		17,766		26,499		26,063
Hay ...tons	47,117	699,029	59,052	874,048	61,658	845,590	81,827	1,151,273	64,916	858,992
Hops ...pounds	17,523,388	1,872,597	16,765,254	1,478,919	11,426,241	1,304,183	17,161,669	2,642,779	21,145,512	3,626,144
Lard substitutes, n. e. s. (cottolene, lardine, etc.) ...pounds	503,859	38,122	1,709,923	102,279	16,261,991	857,708	21,343,028	1,118,659	22,144,717	1,200,231
Malt ...bushels	162,006	110,323	200,042	126,942	289,543	177,292	406,702	287,473	453,038	324,145
Malt sprouts		(*a*)		(*a*)		(*a*)		15,124		55,177
Malt liquors:										
Bottled ...dozen bottles	426,777	492,448	492,055	590,116	549,910	636,837	406,231	497,031	1,433,799	1,733,373
Unbottled ...gallons	258,620	66,322	290,383	69,759	390,048	87,112	391,802	88,548	602,055	154,751
Total		558,770		659,875		723,949		585,579		1,888,124
Must		16,000		18,500		(*a*)		(*a*)		(*a*)
Nursery stock		129,551		133,735		135,047		96,330		134,929

Oil cake and oil-cake meal:										
Corn ......pounds..	(a)	(a)	(a)	(a)	(a)	(a)	2,202,680	20,286	1,922,264	17,623
Cotton-seed ......do....	489,716,053	4,310,128	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
Flaxseed, or linseed ......do....	243,936,442	2,855,459	393,429,432	4,209,415	433,106,448	4,095,244	436,206,321	4,540,824	487,177,390	5,277,744
Total *b* ......do....	733,652,495	7,165,587	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
Oils, vegetable:										
Corn ......gallons..	(a)	(a)	(a)	(a)	(a)	(a)	2,646,560	575,646	2,360,623	565,293
Cotton-seed ......do....	21,187,728	6,813,313	19,445,848	5,476,510	27,198,882	6,897,361	40,230,784	10,157,619	50,627,219	12,077,519
Linseed ......do....	62,718	37,363	67,159	33,260	111,262	42,700	90,074	38,439	107,000	47,681
Volatile, or essential—										
Peppermint ......pounds..	87,633	194,616	85,290	174,810	162,492	257,484	145,375	180,811	117,462	118,227
Other	......	190,798	......	102,487	......	146,569	......	201,497	......	162,358
All other	......	106,022	......	309,955	......	1,167,504	......	885,057	......	838,257
Total......	......	7,342,112	......	6,097,022	......	8,511,618	......	12,019,069	......	13,809,335
Rice and rice meal:										
Rice......pounds..	124,296	4,687	1,346,876	14,117	387,288	14,617	637,146	27,501	852,704	38,511
Rice bran, meal, and polish......do....	1,499,040	11,767	13,684,678	79,637	3,518,466	20,113	5,563,841	35,498	14,481,985	80,298
Total ......do....	1,623,336	16,454	15,031,554	93,754	3,905,754	34,730	6,200,987	62,999	15,334,689	118,809
Rice root. (*See* Broom root.)										
Roots, herbs, and barks, n. e. s......	......	232,095	......	153,896	......	154,347	......	147,839	......	169,828
Seeds:										
Cotton ......pounds..	11,051,812	86,695	26,980,110	179,621	26,566,024	170,604	32,764,781	197,258	34,443,806	197,023
Flaxseed, or linseed......bushels..	1,224	1,433	80,453	73,207	4,713,747	3,850,835	257,228	231,237	2,830,991	2,815,449
Grass seed—										
Clover ......pounds..	22,900,672	2,124,997	5,539,787	437,493	13,042,994	1,003,157	31,155,381	1,892,101	19,980,434	1,264,922
Timothy ......do....	4,939,237	277,160	11,894,536	518,755	16,733,993	574,457	10,238,780	317,173	16,149,611	492,710
Other	......	(a)	......	(a)	......	(a)	......	167,109	......	156,200
Total grass seed......	......	(a)	......	(a)	......	(a)	......	2,376,383	......	1,913,832
All other seeds	......	358,860	......	382,941	......	429,379	......	149,845	......	153,092
Total seeds	......	2,849,145	......	1,592,017	......	6,028,432	......	2,954,723	......	5,079,396
Spices......	......	871	......	1,367	......	772	......	3,841	......	2,257
Spirits, distilled:										
Alcohol, including cologne spirits, proof gallons	*c* 676,832	*c* 181,393	*c* 331,407	*c* 85,292	*c* 416,725	*c* 140,046	1,619,230	463,316	1,476,028	427,288
Brandy ......proof gallons..	100,719	94,924	89,259	87,294	11,815	12,640	24,886	39,455	20,944	29,289
Rum......do....	879,153	1,134,965	865,643	1,174,093	808,393	1,102,267	607,634	845,673	850,719	1,175,306

a Not stated. *b* Prior to 1898 exclusive of corn oil cake, of which the exports were inconsiderable. *c* Including wood alcohol.

Agricultural exports (domestic) of the United States during the five years ended June 30, 1899—Continued.

Articles exported.	1895.		1896.		1897.		1898.		1899.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
VEGETABLE MATTER—continued.										
Spirits, distilled—Continued.										
Whisky—										
Bourbon ....proof gallons..	1,442,685	$1,485,525	139,866	$187,336	569,413	$422,451	286,599	$241,066	224,918	$267,865
Rye ....do....	17,672	34,755	26,630	45,268	21,282	38,402	17,495	31,164	99,884	156,617
Other ....do....	154,703	60,124	336,424	151,521	500,338	225,897	36,869	30,149	19,536	24,372
Total ....do....	3,271,764	2,991,686	1,789,229	1,730,804	2,327,966	1,941,703	2,592,713	1,651,123	2,692,029	2,080,737
Starch ....pounds..	11,788,990	366,800	31,829,435	885,198	79,088,876	1,665,926	72,806,313	1,371,549	110,193,776	2,292,843
Straw	....	3,639	....	5,293	....	5,659	....	5,907	....	4,737
Sugar and molasses:										
Molasses and sirup—										
Molasses ....gallons..	9,148,711	850,400	6,953,307	737,870	8,913,830	788,323	3,817,829	267,202	5,682,080	444,392
Sirup ....do....							7,573,541	794,727	10,070,650	1,465,849
Total molasses and sirup.do....	9,148,711	850,400	6,953,307	737,870	8,913,830	788,323	11,391,370	1,061,929	15,752,730	1,910,241
Sugar—										
Brown ....pounds..	695,486	22,052	296,265	10,389	1,107,864	35,367	460,682	17,353	403,119	14,275
Refined ....do....	8,833,522	406,924	9,106,259	450,753	7,197,355	341,641	6,047,608	301,511	9,462,228	426,202
Total sugar ....do....	9,529,008	428,976	9,402,524	461,142	8,305,219	377,008	6,508,290	318,864	9,865,347	440,477
Total sugar and molasses..........	....	1,279,376	....	1,199,012	....	1,165,331	....	1,380,793	....	2,350,718
Sugar meal ....pounds..	(a)	(a)	3,930,412	66,935	(a)	(a)	(a)	(a)	(a)	(a)
Teazels	....	1,281	....	6,287	....	3,336	....	13,290	....	19,466
Tobacco:										
Leaf ....pounds..	293,805,855	25,622,776	287,700,301	24,405,245	305,978,292	24,513,567	252,258,902	21,924,337	272,421,295	25,170,771
Stems and trimmings ....do....	7,186,075	176,192	7,839,011	166,117	8,953,399	197,879	10,761,312	247,243	11,191,827	296,447
Total ....do....	300,991,930	25,798,968	295,539,312	24,571,362	314,931,691	24,711,446	263,020,214	22,171,580	283,613,122	25,467,218
Vegetables:										
Beans and peas ....bushels..	242,680	429,002	473,975	632,073	900,219	1,110,387	854,284	1,094,094	883,201	1,269,812
Onions ....do....	53,335	46,703	82,916	61,181	73,511	60,088	100,148	90,832	164,902	134,250
Potatoes ....do....	572,957	418,221	680,049	371,485	926,646	515,067	605,187	460,666	579,833	450,739
Vegetables, canned	....	441,388	....	407,506	....	408,840	....	386,039	....	555,691

Other, including pickles and sauces		208,144		182,805		243,542		350,157		388,908
Total		1,543,458		1,655,050		2,337,924		2,381,788		2,799,400
Vinegar ...gallons	80,234	11,273	123,163	16,975	93,969	11,572	108,657	12,939	107,317	13,488
Wines:										
Bottled ...dozen bottles	13,919	56,202	17,147	69,460	16,794	69,444	9,672	46,721	10,973	52,015
Unbottled ...gallons	1,125,297	545,708	1,339,090	581,827	1,389,375	629,270	1,623,103	682,028	1,498,078	624,315
Total		601,910		651,287		698,714		728,749		676,330
Yeast		44,599		45,077		42,849		41,770		36,061
Total vegetable matter		381,928,642		391,133,452		501,432,972		641,210,893		574,433,983
Total agricultural exports		558,385,861		574,398,264		689,755,193		859,018,946		792,811,733

a 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 1895–1899.

[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 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—				
	1895.	1896.	1897.	1898.	1899.
ANIMAL MATTER.					
Cattle, free of duty ....head..	$6.63	$20.56	$119.41	$132.81	$152.81
Cattle, dutiable ....do....	4.95	6.89	7.80	9.75	11.17
Total cattle ....do....	5.11	6.93	7.87	9.99	11.62
Horses, free of duty ....do....	330.17	196.34	138.85	181.82	277.65
Horses, dutiable ....do....	53.88	50.72	58.38	117.92	129.01
Total horses ....do....	80.56	66.32	66.42	134.49	181.15
Sheep, free of duty ....do....	15.90	10.85	13.70	14.05	19.25
Sheep, dutiable ....do....	2.25	2.54	2.45	2.73	3.36
Total sheep ....do....	2.34	2.65	2.51	2.82	3.47
Beeswax ....pound..	.274	.278	.249	.266	.243
Bristles, crude, not sorted, bunched or prepared ....pound..	.399	2.23	.611	.346	.579
Bristles, sorted, bunched, or prepared.....do....	.958	.912	.903	.814	.788
Total bristles ....do....	.956	.913	.903	.814	.785
Butter ....do....	.179	.164	.160	.171	.167
Cheese ....do....	.141	.139	.135	.134	.132
Eggs ....dozen..	.120	.094	.082	.049	.095
Silk:					
Cocoons ....pound..	.434	.405	....	.381	.169
Raw, or as reeled from the cocoon.....do....	2.76	3.28	2.84	3.05	3.28
Waste ....do....	.449	.372	.285	.374	.421
Total silk ....do....	2.43	2.86	2.37	2.66	2.89
Wool, class 1, clothing:					
In the grease ....pound..	....	....	.158	.170	.150
Scoured ....do....	....	....	.265	.280	.155
Total wool, class 1 ....do....	.153	.166	.171	.175	.150
Wool, class 2, combing:					
In the grease ....do....	....	....	.189	.199	.272
Scoured ....do....	....	....	.211	.210	.165
Total wool, class 2 ....do....	.196	.223	.189	.199	.272
Wool, class 3, carpet:					
In the grease ....do....	....	....	.105	.096	.094
Scoured ....do....	....	....	.118	.088	.097
Total wool, class 3 ....do....	.091	.097	.105	.096	.094
Total wools ....do....	.124	.141	.152	.126	.108
Glue ....do....	.088	.089	.096	.104	.089
Hides and skins, other than furs:					
Goatskins ....do....	.202	.220	.227	.243	.265
Hides of cattle ....do....	.088	.124	.106	.108	.104
Other ....do....				.140	.148
Total hides and skins ....do....	.115	.145	.135	.151	.157
Honey ....gallon..	.341	.383	.415	.395	.409
Sausage, Bologna ....pound..	....	.225	.233	....	....
Oils, animal, n.e.s., except whale and fish.gallon..	.320	.327	.158	.404	.173
Stearin ....pound..	....	.071	....	....	.014
VEGETABLE MATTER.					
Argols, or wine lees ....pound..	.068	.096	.084	.083	.082
Barley ....bushel..	.410	.379	.310	.351	.486
Corn (maize) ....do....	.456	.433	.329	.433	.388
Oats ....do....	.262	.274	.260	.370	.385
Oatmeal ....pound..	.056	.057	.021	.055	.059
Rye ....bushel..	.486	1.89	2.36	.404	2.44
Wheat ....do....	.608	.657	.767	.952	7.52
Wheat flour ....barrel..	4.44	4.91	4.41	4.46	4.48
Chocolate, other than confectionery and sweetened chocolate ....pound..	.195	.173	.163	.151	1.79
Cocoa, or cacao, crude, and leaves and shells of, pound	.109	.103	.095	.136	.143
Cocoa, or cacao, prepared or manufactured, pound	.337	.330	.297	.357	.319
Total cocoa, or cacao ....pound..	.120	.114	.105	.143	.147
Coffee ....do....	.147	.146	.111	.075	.066

Average import price of agricultural products imported into the United States during each of the five fiscal years 1895–1899—Continued.

Articles imported.	Years ended June 30—				
	1895.	1896.	1897.	1898.	1899.
VEGETABLE MATTER—continued.					
Chicory root, raw, unground .... pound..	$0.017	$0.013	$0.014	$0.016	$0.015
Chicory root, roasted, ground, or otherwise prepared .... pound..	.033	.033	.035	....	.033
Total chicory root .... do....	.017	.014	.014	.016	.027
Coffee substitutes, n. e. s .... do....	.039	.038	.037	.034	.037
Total coffee substitutes .... do....	.022	.017	.017	.030	.033
Cotton .... do....	.096	.119	.113	.095	.100
Flax, and tow of .... ton..	201.43	179.21	168.01	215.88	201.81
Flax, hackled, etc .... do....	472.16	488.62	375.01		
Hemp, and tow of .... do....	122.22	125.26	124.27	139.49	121.06
Hemp, hackled, etc .... do....	164.46	243.05	273.71		
Istle, or Tampico fiber .... do....	46.65	58.78	53.20	50.84	64.31
Jute and jute butts .... do....	24.88	22.49	23.93	22.65	27.61
Manila hemp .... do....	80.76	76.30	73.68	64.44	116.77
Sisal grass .... do....	57.64	65.47	60.61	74.58	128.12
Fibers, vegetable, n. e. s .... do....	52.79	41.13	66.32	62.22	68.74
Fruit juices:					
Prune juice or prune wine .... gallon..	.739	.830	.701	.890	.776
Other, including cherry juice .... do....	....	....	....	.489	.517
Total fruit juices .... do....	....	....	....	.621	.631
Currants .... pound..	.016	.017	.020	.033	.026
Dates .... do....	.021	.020	.024	.027	.025
Figs .... do....	.050	.054	.060	.053	.049
Plums and prunes .... do....	.037	.142	.103	.130	.106
Raisins .... do....	.041	.043	.045	.058	.057
Almonds .... do....	.103	.098	.091	.115	.123
Ginger, preserved or pickled .... do....	....	....	....	....	.044
Hay .... ton..	7.10	9.16	8.59	8.92	5.81
Hops .... pound..	.191	.217	.209	.273	.449
Indigo .... do....	.509	.501	.482	.586	.543
Malt, barley .... bushel..	.677	.856	.847	.925	.892
Malt liquors, bottled .... gallon..	.953	.970	.978	.948	.999
Malt liquors, unbottled .... do....	.303	.293	.279	.285	.296
Total malt liquors .... do....	.510	.507	.526	.479	.523
Oil cake .... pound..	.007	.006	.007	.004	.005
Olive oil, salad .... gallon..	1.23	1.17	1.22	1.25	1.17
Opium, crude or unmanufactured .... pound..	2.04	1.87	2.04	2.14	2.38
Opium, prepared .... do....	6.58	7.44	7.21	6.51	6.67
Total opium .... do....	3.31	3.06	2.70	4.10	3.22
Rice .... do....	.017	.016	.019	.022	.020
Rice flour, rice meal, and broken rice .... do....	.014	.013	.015	.016	.015
Total rice and rice meal .... do....	.016	.015	.018	.020	.019
Linseed, or flaxseed .... bushel..	1.09	1.08	1.03	1.11	1.07
Spices, unground:					
Nutmegs .... pound..	.311	.320	.270	.273	.241
Pepper, black or white .... do....	.039	.039	.047	.065	.058
Other (free of duty) .... do....	.059	.052	.053	.065	.072
Spices, ground (and other dutiable) .... do....	.132	.113	.111	.100	.099
Total spices .... do....	.063	.060	.064	.076	.030
Spirits, distilled:					
Of domestic manufacture, returned, proof gallon	.870	.913	.903	.860	.836
Brandy .... proof gallon..	2.60	2.66	2.70	2.87	2.85
Other .... do....	1.09	1.16	1.20	1.30	1.37
Total distilled spirits .... do....	1.23	1.21	1.27	1.21	1.29
Starch .... pound..	.019	.018	.018	.017	.016
Straw .... ton..	3.17	3.95	3.38	3.08	2.20
Molasses .... gallon..	.086	.157	.158	.151	.136
Beet sugar not above No. 16 Dutch standard, pound	.020	.023	.018	.019	.021
Sugar, other than beet, not above No. 16 Dutch standard .... pound..	.021	.022	.021	.023	.024
Sugar above No. 16 Dutch standard .... do....	.028	.029	.025	.024	.027
Total sugar .... do....	.021	.023	.020	.022	.024
Tea .... do....	.135	.135	.131	.140	.131
Tobacco, leaf:					
Suitable for cigar wrappers .... do....	1.27	1.07	.935	.931	1.05
Other (including stems) .... do....	.359	.394	.506	.551	.561
Total leaf tobacco .... do....	.553	.501	.694	.715	.705
Vanilla beans .... do....	3.61	4.30	5.36	4.37	4.54
Beans and peas .... bushel..	1.01	1.07	1.01	.912	.899
Cabbages .... number..	....	.044	.055	....	....
Onions .... bushel..	....	....	1.12	.878	.647
Potatoes .... do....	.450	.728	.591	.404	.555
Vinegar .... gallon..	.264	.303	.270	.261	.252
Champagne and other sparkling wines, dozen bottles	14.77	14.73	14.64	14.58	13.98
Still wines, bottled .... dozen bottles..	4.82	4.86	4.77	4.88	4.90
Still wines, unbottled .... gallon..	.697	.688	.680	.721	.698

Average export price of agricultural products exported from the United States during each of the five fiscal years 1895–1899.

Articles exported.	Years ended June 30—				
	1895.	1896.	1897.	1898.	1899.
ANIMAL MATTER.					
Cattle .... head..	$92.26	$92.79	$92.70	$86.12	$78.35
Hogs .... do....	10.16	10.80	10.30	7.67	6.88
Horses .... do....	157.99	140.52	120.64	120.75	118.93
Mules .... do....	74.14	68.63	72.97	82.09	76.52
Sheep .... do....	6.48	6.26	6.27	6.08	5.96
Beeswax .... pound..	.294	.296	.289	.277	.275
Butter .... do....	.164	.152	.143	.150	.161
Cheese .... do....	.091	.084	.091	.086	.087
Eggs .... dozen..	.168	.147	.139	.163	.174
Feathers, other than ostrich .... pound..	*a* .168	.166	.099	....	....
Glue .... do....	.097	.095	.095	.090	.094
Hides and skins, other than furs .... do....	.064	.098	.077	.088	.092
Beef, canned .... do....	.089	.088	.086	.088	.091
Beef, fresh .... do....	.088	.084	.078	.084	.083
Beef, salted or pickled .... do....	.057	.056	.052	.053	.054
Beef, other cured .... do....	.090	.115	.089	.094	.092
Tallow .... do....	.050	.044	.037	.038	.041
Bacon .... do....	.083	.079	.068	.071	.074
Hams .... do....	.104	.098	.097	.095	.092
Pork, fresh .... do....	.074	.059	.073	.067	.066
Pork, salted or pickled .... do....	.071	.057	.049	.056	.058
Lard .... do....	.078	.066	.051	.056	.059
Mutton .... do....	.081	.075	.078	.085	.078
Oleo-oil .... do....	.091	.078	.059	.060	.064
Oleomargarin (imitation butter) .... do....	.098	.097	.097	.089	.092
Lard oil .... gallon..	.549	.511	.437	.395	.450
Other animal oils, except whale and fish .. do....	.523	.504	.425	.409	.387
Total animal oils, except whale and fish ... do....	.544	.510	.435	.397	.440
Silk waste .... pound..	.356	.304	.244	.123	.125
Stearin .... do....	.059	.051	.051	.047	.048
Wool .... do....	.113	.123	.118	.149	.141
VEGETABLE MATTER.					
Barley .... bushel..	.491	.404	.382	.493	.607
Bran, middlings, and mill feed .... ton....	....	....	....	14.58	15.65
Bread and biscuit .... pound..	.045	.045	.046	.049	.049
Buckwheat .... bushel..	....	....	.405	.430	.532
Corn (maize) .... do....	.529	.378	.306	.355	.396
Corn meal .... barrel..	2.90	2.36	1.90	2.13	2.24
Oats .... bushel..	.352	.260	.249	.298	.323
Oatmeal .... pound..	.028	.024	.023	.021	.022
Rye .... bushel..	.566	.450	.428	.568	.585
Rye flour .... barrel..	3.20	2.96	2.87	3.46	3.11
Wheat .... bushel..	.576	.655	.753	.983	.748
Wheat flour .... barrel..	3.38	3.56	3.84	4.51	3.95
Cider .... gallon..	.128	.128	.122	.129	.131
Cotton, sea-island .... pound..	.182	.199	.189	.177	.167
Cotton, other than sea-island .... do....	.058	.080	.074	.059	.055
Total cotton in bales .... do....	.058	.081	.074	.060	.056
Waste cotton .... do....	....	....	....	.041	.037
Total cotton .... do....	.058	.081	.074	.060	.055
Apples, dried .... do....	.065	.050	.044	.061	.065
Apples, green or ripe .... barrel..	2.39	2.58	1.58	2.78	3.18
Prunes .... pound..	....	....	....	.064	.068
Raisins .... do....	....	....	....	.054	.052
Ginseng .... do....	3.54	3.86	4.68	3.67	3.99
Glucose, or grape sugar .... do....	.019	.016	.014	.015	.016
Hay .... ton..	14.84	14.80	13.71	14.07	13.23
Hops .... pound..	.107	.088	.114	.154	.171
Lard substitutes, n. e. s. (cottolene, lardine, etc.) pound	.076	.060	.053	.052	.054
Malt .... bushel..	.681	.635	.612	.707	.715
Malt liquors, bottled .... dozen bottles..	1.15	1.20	1.16	1.22	1.21
Malt liquors, unbottled .... gallon..	.256	.240	.223	.226	.257
Corn oil cake .... pound..	....	....	....	.009	.009
Oil cake and oil-cake meal, cotton-seed .... do....	.009	.009	.009	.009	.009
Oil cake and oil-cake meal, flaxseed, or linseed, pound	.012	.011	.009	.010	.011
Total oil cake and oil-cake meal .... pound..	.010	.010	.009	.009	.009
Corn oil .... gallon..	....	....	....	.218	.239
Cotton-seed oil .... do....	.322	.282	.254	.252	.239
Linseed oil .... do....	.596	.495	.384	.427	.446
Peppermint oil .... pound..	2.22	2.05	1.58	1.24	1.01
Rice .... do....	.038	.010	.038	.043	.045
Rice bran, meal, and polish .... do....	.008	.006	.006	.006	.006
Total rice and rice meal .... do....	.010	.006	.009	.010	.008
Cotton seed .... do....	.008	.007	.006	.006	.006

a Exclusive of egret feathers.

Average export price of agricultural products exported from the United States during each of the five fiscal years 1895–1899—Continued.

Articles exported.	Years ended June 30—				
	1895.	1896.	1897.	1898.	1899.
VEGETABLE MATTER—continued.					
Flaxseed, or linseed .... bushel..	$1.17	$0.910	$0.820	$0.899	$0.995
Clover seed .... pound..	.093	.079	.077	.061	.063
Timothy seed .... do....	.056	.044	.034	.031	.031
Alcohol, including cologne spirits.. proof gallon..	*a* .268	*a* .257	*a* .336	.286	.289
Brandy .... do....	.942	.978	1.07	1.59	1.40
Rum .... do....	1.29	1.36	1.36	1.39	1.38
Bourbon whisky .... do....	1.03	1.34	.742	.841	1.19
Rye whisky .... do....	1.97	1.70	1.80	1.78	1.57
Distilled spirits, n. e. s .... do....	.389	.450	.451	.818	1.25
Total distilled spirits .... do....	.914	.967	.834	.637	.773
Starch .... pound..	.031	.028	.021	.019	.021
Molasses .... gallon..	....	....	....	.070	.078
Sirup .... do....	....	....	....	.105	.146
Total molasses and sirup .... do....	.093	.106	.088	.093	.121
Sugar, brown .... pound..	.032	.035	.032	.038	.035
Sugar, refined .... do....	.046	.049	.047	.050	.045
Total sugar .... do....	.045	.049	.045	.049	.045
Sugar meal .... do....	....	.017	....	....	....
Tobacco, leaf .... do....	.087	.085	.080	.087	.092
Tobacco, stems and trimmings .... do....	.025	.021	.022	.023	.026
Total tobacco .... do....	.086	.083	.078	.084	.090
Beans and peas .... bushel..	1.77	1.33	1.23	1.28	1.44
Onions .... do....	.876	.738	.817	.907	.814
Potatoes .... do....	.730	.546	.556	.761	.777
Vinegar .... gallon..	.141	.138	.123	.119	.126
Wines, bottled .... dozen bottles..	4.04	4.05	4.14	4.83	4.74
Wines, unbottled .... gallon..	.485	.434	.453	.420	.417

a Including wood alcohol.

SUGAR STATISTICS.

[From Section of Foreign Markets.]

Quantity of sugar imported into the United States from the principal countries of supply during each fiscal year from 1895 to 1899, inclusive.

Countries from which imported.	Years ended June 30—					Annual average, 1895–1899.	
	1895.	1896.	1897.	1898.	1899.		
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per ct.*
Cuba	1,845,763,398	1,093,171,312	577,790,173	440,225,111	663,543,657	924,098,730	24.24
Germany	311,182,968	525,991,657	1,604,233,071	175,275,440	667,127,773	656,762,182	17.23
Dutch East Indies	280,464,270	567,670,780	634,171,629	621,731,462	986,438,330	618,095,294	16.21
Hawaiian Islands	274,385,228	352,175,269	431,217,116	499,776,895	462,423,600	403,995,622	10.60
British West Indies	193,498,237	217,421,118	322,103,866	231,401,746	267,565,738	246,398,141	6.46
British Guiana	110,848,960	146,433,256	175,639,179	139,145,529	138,152,464	142,043,878	3.73
Brazil	180,262,039	191,457,878	140,773,692	139,426,285	41,222,162	138,628,411	3.64
Santo Domingo	66,492,169	116,972,841	131,279,582	94,336,444	112,213,037	104,258,815	2.74
Egypt	23,250,815	100,335,317	124,055,211	52,354,144	141,940,690	88,387,236	2.32
Puerto Rico ...	56,352,954	81,582,810	86,607,317	98,452,421	107,208,014	86,040,703	2.26
Philippine Islands	68,770,492	145,075,341	72,463,577	29,489,600	51,625,280	73,484,859	1.93
Belgium	24,338,139	72,721,186	130,423,987	1,366,370	30,000	45,775,937	1.20
Austria-Hungary	7,411,234	40,703,929	105,138,128	2,788,767	69,397,343	45,087,880	1.18
United Kingdom	40,610,295	56,992,162	68,250,019	21,106,706	16,685,790	40,728,995	1.07
Netherlands ...	12,600,203	40,965,863	82,248,664	38,659,827	6,894,728	36,273,857	.95
France	35,832	34,810,370	92,169,241	17,781	66,007	25,419,846	.67
British Africa.	3,776,030	26,564,115	25,895,460	12,081,142	55,075,128	24,678,375	.65
Dutch Guiana .	8,794,544	12,299,609	18,043,833	25,636,341	38,124,370	20,579,739	.54
China	23,696,923	31,827,859	11,437,760	7,161,664	10,758,164	16,976,474	.45
Danish West Indies	9,131,589	12,202,619	16,999,347	14,832,991	22,711,543	15,175,618	.40
Argentina	....	6,341,221	46,940,759	12,428,502	....	13,142,096	.34
British East Indies	8,908,277	2,565,592	11,173,293	9,381,265	29,599,283	12,325,542	.32
Peru	....	....	2,863,350	8,544,857	50,080,303	12,297,702	.32
Hongkong	8,351,495	12,046,973	3,243,630	4,183,246	5,084,695	6,582,008	.17

Quantity of sugar imported into the United States from the principal countries of supply during each fiscal year from 1895 to 1899, inclusive—Continued.

Countries from which imported.	Year ended June 30—					Annual average, 1895–1899.	
	1895.	1896.	1897.	1898.	1899.		
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per ct.*
Russia, European	------------	------------	815,702	242,575	14,800,295	3,171,714	0.08
Mexico	3,021,232	4,006,707	1,412,255	3,059,018	3,088,609	2,917,564	.08
Canada	8,329,961	1,304,887	1,098,330	717,532	2,020,601	2,694,142	.07
Guatemala	577,650	------------	------------	4,921,135	4,477,566	1,995,270	.05
Dutch West Indies	------------	1,972,828	86,652	277,260	5,085,441	1,484,436	.04
Turkey, Asiatic	------------	------------	------------	------------	3,361,397	672,279	.02
Salvador	------------	------------	------------	------------	2,471,012	494,202	.01
Other countries	3,655,520	725,055	330,910	898,795	978,149	1,317,686	03
Total	3,574,510,454	3,896,338,557	4,918,905,733	2,689,920,851	3,980,250,569	3,811,985,233	100.00

Value of sugar imported into the United States from the principal countries of supply during each fiscal year from 1895 to 1899, inclusive.

Countries from which imported.	Years ended June 30—					Annual average, 1895–1899.	
	1895.	1896.	1897.	1898.	1899.		
	Dollars.	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Dollars.*	*Per ct.*
Cuba	40,100,204	24,102,835	11,982,473	9,828,607	16,412,088	20,485,241	24.38
Germany	6,332,916	12,528,755	29,844,019	3,520,796	14,095,417	13,264,380	15.78
Hawaiian Islands	7,403,658	11,336,796	13,165,084	16,660,412	17,292,723	13,171,735	15.67
Dutch East Indies	5,759,436	11,388,487	13,090,323	11,250,181	19,817,646	12,261,215	14.59
British West Indies	3,989,614	4,700,527	5,893,877	4,552,454	6,049,479	5,037,190	5.99
British Guiana	2,517,726	3,414,368	3,657,025	3,045,666	3,461,889	3,219,335	3.83
Brazil	2,701,287	3,776,486	2,136,989	2,317,990	810,276	2,348,606	2.79
Egypt	596,277	2,657,425	2,616,423	1,230,071	3,570,343	2,134,108	2.54
Santo Domingo	1,188,951	2,459,302	2,059,169	2,030,239	2,659,456	2,079,423	2.47
Puerto Rico	994,084	1,707,318	1,577,911	1,913,742	2,495,849	1,737,781	2.07
Philippine Islands	1,111,006	2,270,902	1,199,202	381,279	969,323	1,186,342	1.41
United Kingdom	976,266	1,402,694	1,452,004	504,714	434,237	953,983	1.14
Austria-Hungary	178,472	958,402	1,957,027	67,831	1,485,037	929,354	1.11
Belgium	458,779	1,771,980	2,311,309	31,909	788	914,953	1.09
Netherlands	296,761	1,182,605	1,916,933	957,908	176,014	906,044	1.08
Dutch Guiana	195,589	289,243	380,959	585,326	953,047	480,833	.57
China	668,287	920,301	313,803	176,751	296,574	475,143	.57
France	1,412	859,359	1,421,317	480	2,506	457,015	.54
British Africa	49,725	461,054	417,850	131,469	835,950	379,210	.45
Danish West Indies	205,333	261,728	316,781	312,446	556,562	330,570	.39
Argentina	------------	159,108	917,457	260,957	------------	267,504	.32
Peru	------------	------------	56,969	148,599	921,430	225,400	.27
British East Indies	94,957	32,839	174,531	134,838	566,297	200,692	.24
Hongkong	236,292	353,610	87,465	107,295	141,767	185,286	.22
Canada	289,060	92,692	74,191	32,589	139,023	125,511	.15
Russia, European	------------	------------	14,927	5,736	340,815	72,296	.09
Guatemala	6,618	------------	------------	212,637	118,262	67,503	.08
Mexico	55,112	63,572	19,111	48,682	52,995	47,894	.06
Dutch West Indies	------------	48,974	1,761	4,811	136,893	38,488	.05
Turkey, Asiatic	------------	------------	------------	------------	85,226	17,045	.02
Salvador	------------	------------	------------	------------	63,459	12,692	.01
Other countries	55,014	18,411	9,291	16,334	22,749	24,360	.03
Total	76,462,836	89,219,773	99,066,181	60,472,749	94,964,120	84,037,132	100.00

TRANSPORTATION RATES.

Grain: average rates, in cents per bushel, from St. Louis to New Orleans by river.

[Compiled from reports of the St. Louis Merchants' Exchange; reprinted from Bulletin No. 15, Miscellaneous Series, Division of Statistics.]

Year.	Grain in sacks per 100 pounds.	Per bushel.		
		Wheat in bulk.	Corn and rye.	
			High water.	Low water.
1866 *a*			9.05	10.93
1867 *a*			11.09	14.83
1868 *a*			6.23	9.84
1869 *a*			6.32	8.42
1870 *a*			9.23	13.66
1871 *a*			6.71	16.29
1872 *a*			9.79	19.04
1873 *a*			6.15	9.67
1874 *a*			4.95	8.09
1875 *a*			4.87	10.01
1876 *a*			5.02	11.30
1877 *a*	20.04	8.11	7.63	8.59
1878 *a*	17.36	7.19	4.96	8.93
1879	18	7.75	5	11
1880	19	8.25	7	9.50
1881	20	6	4	8
1882	20	6.42	5.50	7
1883	17.75	5.50	5	7
1884	14	6.63	5	7
1885	15	6.40	5	7
1886	16	6.50	5	7
1887	18.25	6	5	7
1888	15	6.50	5	7.50
1889	17.93	5.95	5	7
1890	15.66	6.58	5	7
1891	16.28	6.88	5	7.50
1892	16.87	6.50	5	7
1893	17.54	6.55		
1894	17.14	5.89		
1895	12.50	5.95		
1896	14.55	5		
1897	15	4.98		
1898	10	4.50		
1899	10	4.50		

a Rates in currency reduced to their equivalents in gold.

Miscellaneous commodities. New York to Chicago by rail.

AVERAGE RATES FOR LESS THAN CARLOAD QUANTITIES, IN CENTS PER 100 POUNDS.

[From Bulletin No. 15, Miscellaneous Series, Division of Statistics.]

Year.	Furniture.	Agricultural implements.	Lead.	Bagging.	Crockery and earthenware.	Coffee.	Starch.	Sugar.	Molasses.	Rice.	Soap.	
											Castile and fancy.	Common.
1867 *a*	137	137	60	117	117	117	117	60	60	60	117	93
1868 *a*	122	122	56	103	103	------	87	------	------	56	103	56
1869 *a*	99	99	54	92	------	------	75	------	------	54	92	54
1870 *a*	113	113	61	98	------	------	78	------	------	------	98	60
1871 *a*	81	81	39	71	49	36	58	36	46	46	71	46
1872 *a*	105	105	43	93	81	43	72	43	55	51	93	55
1873 *a*	69	------	31	62	31	31	50	31	40	31	62	40
1874 *a*	81	------	37	74	37	37	62	37	49	37	74	49
1875 *a*	53	------	25	48	29	24	40	24	41	25	48	33
1876 *a*	39	------	20	37	20	20	32	20	23	20	37	23
1877 *a*	72	------	33	56	33	33	50	33	40	33	65	40
1878 *a*	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

a Rates in currency reduced to their equivalents in gold.

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.	Soap. Common.
1867 *a*	137	137	60	117	117	117	117	60	60	60	117	93
1868 *a*	122	122	56	103	103	......	87	......	....	56	103	56
1869 *a*	99	99	54	92	....	......	75	......	....	54	92	54
1870 *a*	113	113	61	98	....	......	78	......	....	......	98	60
1871 *a*	81	81	39	71	49	36	58	36	46	46	71	46
1872 *a*	105	105	43	93	81	43	72	43	55	51	93	55
1873 *a*	69	54	31	62	31	31	50	31	40	31	62	40
1874 *a*	81	49	37	74	37	37	62	37	49	37	74	49
1875 *a*	53	33	25	48	29	24	40	24	41	25	48	33
1876 *a*	39	23	20	37	20	20	32	20	23	20	37	23
1877 *a*	72	39	33	56	33	33	50	33	40	33	65	40
1878 *a*	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	24	30	25	25	25
1893	65	30	25	35	30	25	25	24	30	25	25	25
1894	65	30	25	35	30	25	25	24	30	25	25	25
1895	65	30	25	35	30	25	25	24	30	25	25	25
1896	65	30	25	35	30	25	25	24	30	25	25	25
1897	65	30	25	35	30	25	25	24	30	25	25	25
1898	65	30	25	35	30	25	25	24	30	25	25	25
1899	65	30	25	35	30	25	25	24	30	25	25	25

a Rates in currency reduced to their equivalents in gold.

Miscellaneous commodities, New York to Chicago by rail—Continued.

AVERAGE RATES, REGARDLESS OF QUANTITY SHIPPED, IN CENTS PER 100 POUNDS.

Year.	Dry goods.	Cotton piece goods.	Boots and shoes.	Tea.	Drugs.
1867 *a*	137	137	137	137	137
1868 *a*	122	122	122	122	122
1869 *a*	99	99	99	99	99
1870 *a*	113	113	113	113	113
1871 *a*	81	81	81	81	81
1872 *a*	105	105	105	105	105
1873 *a*	69	69	69	69	69
1874 *a*	81	81	81	81	81
1875 *a*	53	53	53	53	53
1876 *a*	39	39	39	39	39
1877 *a*	72	72	72	72	72
1878 *a*	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

a Rates in currency reduced to their equivalents in gold.

Live stock and dressed meats, Chicago to New York by rail.

AVERAGE RATES, IN CENTS PER 100 POUNDS.

[From Bulletin No. 15, Miscellaneous Series, Division of Statistics.]

Year.	Cattle.	Hogs.	Sheep.	Horses and mules.	Dressed beef.	Dressed hogs.	
						Refrigerator cars.	Common cars.
1872 *a*					81		
1873 *a*					83		
1874 *a*					85		
1875 *a*					72		
1876 *a*					62		
1877 *a*					72		
1878 *a*					79		
1879	47	45	61	60	82		
1880	55	43	65	60	88		
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	*b*25	25	25	60	40	40	40

a Rates in currency reduced to their equivalents in gold.
b 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.

[Compiled from reports of Cincinnati Chamber of Commerce.]

[From Bulletin No.15, Miscellaneous Series, Division of Statistics.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	The year.
1868 *a*	56.3	53.0	53.8	45.4	43.0	42.8	42.0	41.2	46.1	51.8	55.8	55.5	48.80
1869 *a*	55.3	49.3	41.9	37.6	35.9	36.2	36.7	37.3	40.2	42.2	46.6	46.9	42.11
1870 *a*	49.5	41.8	44.4	44.2	43.6	40.0	38.5	38.2	43.6	44.3	45.8	49.7	43.59
1871 *a*	49.7	49.3	45.6	40.7	40.4	36.8	37.8	40.0	40.2	46.3	53.8	54.9	44.59
1872 *a*	55.0	54.4	54.5	49.5	48.4	46.4	39.4	39.3	45.5	50.7	53.1	53.5	49.07
1873 *a*	53.2	52.6	51.9	50.9	48.8	42.9	43.2	41.6	40.8	43.6	43.7	44.3	46.51
1874 *a*	44.9	43.9	40.1	30.9	32.3	35.9	36.4	36.5	36.5	35.2	33.4	31.8	36.48
1875 *a*	29.3	28.8	28.6	28.7	28.5	21.4	21.8	22.0	21.6	25.3	28.8	32.9	26.47
1876 *a*	37.2	37.0	35.4	29.9	22.2	22.2	22.3	22.5	22.7	22.8	22.9	24.8	26.91
1877 *a*	32.7	35.4	31.5	27.7	27.1	30.7	31.3	27.6	28.1	29.5	32.1	32.1	30.47
1878 *a*	32.3	32.4	27.9	24.9	23.8	20.8	20.6	24.4	28.6	28.9	29.6	33.0	27.26
1879	33.0	30.4	26.2	21.0	21.0	18.3	21.5	26.6	30.5	33.3	37.9	39.0	28.19
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

a Rates in currency reduced to their equivalents in gold; average currency values of gold for specific months used in making reductions.

Grain, Chicago to New York.

AVERAGE RATES, IN CENTS PER BUSHEL.

[From Bulletin No. 15, Miscellaneous Series, Division of Statistics.]

Year.	Wheat.				Corn.	
	Via lake and rail.		Via all rail.		Via lake and rail.	Via all rail.
	As reported by New York Produce Exchange.	As reported by Chicago Board of Trade.	As reported by New York Produce Exchange.	As reported by Chicago Board of Trade.	As reported by Chicago Board of Trade.	As reported by Chicago Board of Trade.
1870 *a*	19.15	19.58	28.98	26.11	19.32	24.37
1871 *a*	22.38	22.76	27.75	28.47	21.24	26.57
1872 *a*	24.91	26.25	29.80	31.13	23.67	29.06
1873 *a*	23.64	21.63	29.17	27.26	20.19	25.42
1874 *a*	15.20	15.37	25.81	23.61	12.48	22.03
1875 *a*	12.71	12.09	20.97	20.89	11.34	19.50
1876 *a*	10.58	10.19	14.80	15.12	9.68	14.12
1877 *a*	15.08	14.75	19.37	19.56	13.42	18.03
1878 *a*	11.31	11.99	17.56	17.56	10.45	16.39
1879	13.30	13.13	17.30	17.74	12.20	14.56
1880	15.70	15.80	19.90	19.80	14.43	17.48
1881	10.40	10.49	14.40	14.40	9.42	13.40
1882	10.90	10.91	14.60	14.47	10.28	13.50
1883	11.50	11.63	16.50	16.20	11.00	15.12
1884	9.95	10.00	13.12	13.20	8.50	12.32
1885	9.02	9.02	14.00	13.20	8.01	12.32
1886	12.00	12.00	16.50	15.00	11.20	14.00
1887	12.00	12.00	*b* 15.74	15.75	11.20	14.70
1888	11.00	11.14	*b* 14.50	14.50	10.26	13.54
1889	*b* 8.70	8.97	15.00	15.00	8.19	12.60
1890	8.50	8.52	14.31	14.30	7.32	11.36
1891	8.53	8.57	15.00	15.00	7.53	14.00
1892	7.55	7.59	14.23	13.80	7.21	12.96
1893	8.44	8.48	14.70	14.63	7.97	13.65
1894	7.00	7.00	12.88	13.20	6.50	12.32
1895	6.95	6.96	12.17	11.89	6.40	10.29
1896	7.32	6.61	12.00	12.00	6.15	10.50
1897	7.37	7.42	12.32	12.50	6.92	11.43
1898	*c* 9.50	4.91	11.55	12.00	4.41	9.80
1899	6.63	6.63	11.13	11.60	5.83	10.08

a Rates in currency reduced to their equivalents in gold.

b Averages based upon officially published tariffs; actual rate lower.

c Averages based upon officially published tariffs; actual rate lower. The lake and rail rate for 1898 actually averaged about 4.95 cents.

Average freight rates, in cents per ton per mile.

[From Bulletin No. 15, Miscellaneous Series, Division of Statistics.]

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.
1870 *a*	3.635	1.851	1.590	1.125	1.269	1.268	1.229	4.101	1.953	2.316	2.380	1.963	3.596	2.513	1.889
1871 *a*	------	1.869	1.457	1.282	1.244	1.211	1.276	4.445	2.077	2.369	2.289	1.968	2.419	2.298	1.789
1872 *a*	3.504	1.800	1.422	1.362	1.227	1.304	1.264	3.643	1.923	2.229	2.177	1.789	2.390	2.053	1.846
1873 *a*	3.289	1.707	1.371	1.267	1.164	1.258	1.220	1.909	1.916	2.002	2.173	1.864	2.153	1.950	1.613
1874 *a*	3.903	1.641	1.319	1.184	1.065	1.164	1.134	1.354	1.881	1.871	2.137	1.916	1.949	1.940	1.520
1875 *a*	3.624	1.346	1.119	1.061	.887	.989	.970	1.299	1.692	1.688	1.833	1.649	2.164	1.687	1.421
1876 *a*	2.218	1.139	.929	.972	.722	.841	.827	1.061	1.587	1.693	1.798	1.438	2.211	1.638	1.217
1877 *a*	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 *a*	1.582	1.113	.919	.960	.724	.914	.867	.985	1.616	1.539	1.762	1.254	2.236	1.635	1.296
1879	1.299	1.100	.793	.779	.641	.822	.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	1.509	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	1.268	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	1.108	.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	1.056	.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	.859
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

a Rates in currency reduced to their equivalents in gold.

Average rates, in cents per passenger per mile.

[From Bulletin No. 15, Miscellaneous Series, Division of Statistics.]

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.
1870 *a*	1.945	2.343	1.770	2.470	2.204	2.167	2.282	3.979	3.290	3.426	3.272	......	4.301	3.194	2.392
1871 *a*	2.010	2.517	1.920	2.396	2.503	2.322	......	4.037	3.358	3.435	3.322	......	3.775	3.340	2.632
1872 *a*	1.923	2.275	1.863	1.904	2.321	2.379	......	3.992	3.034	3.229	3.404	......	3.730	3.240	2.521
1873 *a*	1.820	2.176	1.799	1.927	2.221	2.317	......	3.686	3.097	3.131	3.039	......	3.541	3.102	2.486
1874 *a*	1.984	2.229	1.929	2.088	2.214	2.349	2.301	3.542	2.966	3.063	2.995	2.949	3.394	3.412	2.544
1875 *a*	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 *a*	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 *a*	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 *a*	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	2.000	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	2.155	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	*b*1.953	2.02	1.943	1.938	2.092	2.362	2.058	1.945	2.152	1.973

a Rates in currency reduced to their equivalents in gold.

b Excludes ferry earnings at Jersey City, N. J.

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