ANNUAL REPORT

OF THE

Maine State College of Agriculture

AND THE

MECHANIC ARTS.

PART II.

AGRICULTURAL EXPERIMENT STATION.

1888.

AUGUSTA:
BURLEIGH & FLYNT, PRINTERS TO THE STATE.
1889.

MAINE STATE COLLEGE.

AGRICULTURAL EXPERIMENT STATION.

STATION COUNCIL.

Hon. Z. A. Gilbert, No. Greene, Me.,
Rutilus Alden, Esq., Winthrop, Me.,
Wm. H. Strickland, Esq., Bangor, Me., } *Committee of Trustees.*

M. C. Fernald, Ph. D . . . . President College.

President.

W. H. Jordan, M. S. . . . . Director Station.

Secretary.

Walter Balentine, M. S. . . . . Professor of Agriculture.

F. L. Harvey, M. S. . . . . Professor of Natural History.

F. L. Russell, V. S. . . . . Veterinarian to Station.

STATION OFFICERS.

W. H. Jordan, M. S. . . . . Director.

M. C. Fernald, Ph. D. . . . . Meteorologist.

Walter Balentine, M. S. . . . . Experimental Agriculture.

F. L. Harvey, M. S. . . . . Botanist and Entomologist.

F. L. Russell, V. S. . . . . Veterinarian.

J. M. Bartlett, M. S. . . . . Chemist.

L. H. Merrill, B. S. . . . . Chemist.

F. P. Briggs . . . . Assistant in Botany and Entomology.

A. M. Shaw, ... Foreman on Farm.

Mrs. Jennie Waitt . . . . Clerk.

TREASURER'S REPORT.

THE MAINE STATE COLLEGE AGRICULTURAL EXPERIMENT STATION.

Receipts and Expenditures for the year ending June 30, 1888.

RECEIPTS.

Annual appropriation from the U. S. Treasury		$15,000 00

EXPENDITURES.

Salaries	$3.496 67	
Construction	3,000 00	
Chemical Laboratory	3,745 52	
Field and Feeding Experiments	664 16	
Live Stock	1,005 00	
Library	1,627 88	
Traveling Expense	338 10	
Printing	254 31	
Stationery and Postage	104 25	
Department of Meteorology	307 79	
Department Botany and Entomology	2 39	
*General Expense	453 93	
		$15,000 00

J. FRED WEBSTER, TREASURER,
Trustees Maine State College, Agr. and Mech. Arts.

I find the above accounts properly vouched and cast.

WILLIAM H. STRICKLAND,
Auditor Trustees Me. State College Agr. and Mech. Arts.

*Mostly office furnishing.

DIRECTOR'S REPORT.

M. C. Fernald, Ph. D., President Maine State College:

SIR:—The work of the Experiment Station for 1888 has been largely that of organization and preparation. This department of the college, which has been created and endowed by the act of Congress, and accepted by the legislature of this State, will, without question, be maintained as a permanent agricultural institution, provided the national appropriation is so applied in this and other States as to meet the approval of the intelligent farming public. In order that the Station organization shall be made on a permanent and progressive basis, such as shall meet not only present, but future needs, in a manner that shall insure the effective application of the funds appropriated, it is necessary to proceed slowly and deliberately at first. This is the reason why at the end of nearly a year's active existence, it is possible to report only a limited amount of actual experimental work begun, and still less so far completed as to report results.

The erection of a building with its equipment of water, gas, apparatus and furniture, the purchase of the appliances for field and feeding experiments, and the special plans for the different departments of Station work have engrossed much time and thought. The inspection of fertilizers, which becomes more and more laborious each year, has also been carried on as usual.

That which has been accomplished in these various directions, it is the purpose of this report to make clear, and it is hoped that what has been done as a beginning, in laying the foundations for future work, will meet with approval.

THE FORMER STATION.

The Maine Legislature of 1885 passed an act locating at the college what was to be known as the Maine Fertilizer Control and Agricultural Experiment Station, appropriating to its support the sum of $5000 annually. This Station was not placed under the control of the trustees of the college, but was intrusted to a board of managers, three of whom were to be appointed by the Governor of the State, the others to be the Secretary of the Board of Agriculture, and the Professor of Agriculture at the college.

This Station existed about two and a half years, and issued twenty bulletins and three reports, the former being published only in the leading papers of the State, and the latter as a part of the report of the Maine Board of Agriculture.

The work of this Station consisted of the inspection of commercial fertilizers, and the conducting of such experiments and investigations as the remaining time and means allowed.

Upon the passage by Congress of what is known as the "Hatch Act," establishing an agricultural experiment station in every State, the legislature of 1887 repealed the law of March 3, 1885, by an act which took effect on October 1, 1887. It was expected at the time this act was passed that by October 1st a Station would be in operation under the provisions of the national law.

This did not prove to be the case, owing to the failure of Congress to appropriate money, and had not the college assumed the risk of advancing the funds to pay the expenses of the Station for another three months, work would have ceased on the date at which the old Station law stood repealed. As it was, work was continued until January 1, 1888, when the Station force disbanded to await the action of Congress.

THE PRESENT STATION.

The congressional act establishing what are known as the national experiment stations, became a law on March 2, 1887, and designated October 1st of that year as the time at which the first quarterly payments for the support of these stations should become due. Congress failed, however, to make the appropriation required by the act named, and so these stations did not go into operation.

It was not until after the passage of a deficiency bill early in February, 1888, that funds became available for the payment of the expenses of the year 1887–8.

Previous to this, the Maine legislature of 1887 had accepted the provision of the "Hatch Act" on the part of the State, and at a meeting of the college trustees in June, 1887, the present Station was organized as a department of the college, by the election of a director and two other members of the staff of officers. It only remained, after the funds had become available, for the trustees to take such steps as were necessary to put the Station into actual operation, which they did at a meeting on February 16, 1888.

RELATION OF THE STATION TO THE COLLEGE.

The act of Congress establishing the Station, creates it as a department of the college, which stands in the same relation to the trustees and president as any other department. At the same time, such are the peculiar conditions under which this department is created, and so essential is it for the college to be able to show that the congressional appropriation is applied according to the intent of the law, it seems necessary for the management of the Experiment Station to be more fully distinct and separate than is the case with the other departments of the college.

At a meeting of delegates of agricultural colleges and experiment stations held in Washington, D. C., Oct. 18–20, 1887, resolutions were adopted, a brief summary of which is given below:

1st. All the appropriations under the "Hatch bill" should be wholly applied to agricultural research and experiment, and not to the general uses of the college.

2d. These stations should be so far separate and distinct from the colleges that it will be possible to show at any time that the funds have been used according to the intent of the law.

3d. Every department known as an experiment station should be distinctly organized with a recognized official head, whose time shall be chiefly devoted to this department.

It is believed that the plan of organization upon which this Station has entered is in conformity to the letter and spirit of these resolutions. It is true that some members of the faculty of the college will divide their time between station work and the instruction of students, but in all cases, increased assistance will be provided to compensate for added duties, and in no instance will the Station funds be used to pay for time devoted to teaching.

ORGANIZATION AND WORK OF THE STATION.

At the meeting of the trustees mentioned above a general plan for carrying out the provisions of the "Hatch bill," involving the expenditure of $15,000 per annum, was presented to the board of trustees, and was accepted by them, and the development and management of the Station under this plan was placed in the immediate charge of an Experiment Station Council, constituted as follows: The president of the college; the director of the Station; the professor of agriculture; the professor of natural history; the Station veterinarian; the Station horticulturist (when appointed).

At a subsequent meeting this council was enlarged by the addition of a committee of the trustees.

In accordance with the action of the trustees the Station Council has perfected the organization of the Station somewhat in detail, and the various lines of work important to Maine agriculture, to which attention will be given, from time to time, as seems expedient, have been assigned to the Station officers, as follows:

(*1*) *Cattle Foods, Cattle Feeding and Animal Products.* (Director of Station.)

The forage crops adapted to Maine agriculture.

The composition of cattle foods, and the influence of varying conditions upon their nutritive value.

The disgestiblity of cattle foods.

The special functions of the ingredients of cattle foods in animal nutrition.

The economical use of foods in the production of milk, meat and other animal products.

The adaptability of the various breeds of animals to the profitable production of milk and meat.

The best methods for the manufacture of butter and cheese, and allied questions.

(*2*) *Fertilizer and Crop Production.* (Prof. Balentine.)

The composition, availability and use of the various kinds of fertilizing material, including commercial and farm manures.

The relation of different cattle foods to the fertility of the farm.

The economy of different systems of farm management as related to the fertility of the soil and to the profits of farming.

Methods of cultivation best calculated to promote the fertility and proper physicial conditions of the soil.

(*3*) *Varieties of Farm Crops, Agricultural Botany and Entomology*, (Prof. Harvey.)

A botanical study of plants, both useful and injurious to Maine Agriculture.

The nature and remedy of the fungoid and other diseases to which agricultural plants are subject.

Inspection of the agricultural seeds sold in Maine to determine their purity and vitality.

The life history and ravages of injurious insects, and the means of their prevention or extermination.

(4) *Animal Diseases.* (Dr. Russell.)

Dr. F. L. Russell, a graduate of the Maine State College and of the New York College of Veterinary Surgeons, New York City, was elected veterinarian to the Station early in 1887, and since that time has been pursuing special studies in bacteriology and pathology at the Johns Hopkins University, Baltimore, in preparation for the work which he is to undertake. He will enter upon his duties at the Station about the first of March, 1889, and will then devote his time largely to a study of the nature of those diseases from which the farm animals of this State seem likely to suffer.

(5) *Horticulture.* (No special provision for this yet.)

It seems desirable that horticulture should find a place in the work of the Station, and it is only necessary that certain facilities be provided in the way of buildings in order that proper attention may be given to this important branch of agriculture. In the mean time as much will be done in this direction as time and facilities permit.

(6) *Agricultural Meteorology and Physics.* (President Fernald.)

This department of experiment and investigation embraces such subjects as temperature, rainfall, evaporation and percolation or drainage, in their relations to the mechanical conditions of the soil and to plant growth. It is now proposed to begin in the spring of 1889 certain meteorological observations, additional to those heretofore made at the college.

(7) *Fertilizer Inspection.*

The new fertilizer law enacted in 1887 gives the Experiment Station the authority to sample and analyze the commercial fertilizers sold in the State, and therefore this inspection will be continued as heretofore.

It will be possible, now that the Station bulletins are to be sent directly to farmers, to distribute information in regard to the character of the fertilizers offered for sale, more promptly than has been the case when the newspapers were the medium of communication.

On the other hand large increase in the brands of fertilizers offered for sale in this State will tend to delay the report of the spring inspection.

Samples can not be collected until the new goods are shipped to dealers, and the greater the number of brands sampled the longer the time required to perform the analysis.

(*8*) *Chemical Analyses*, (Mr Bartlett and Mr. Merrill.)

It is to be noticed that of the nine Station officers two are chemists, who will devote nearly their entire time to analytical chemistry, with perhaps some assistance. Almost all of the experimental work to be undertaken in the field, barn or dairy, will require the aid of the chemist in obtaining the data necessary to full and safe conclusions. Conclusions from experiments in plant feeding and cattle feeding are often looked upon with suspicion as a guide to practice, unless chemical analysis is employed to give full information about the materials used, and the products obtained. Moreover, the amount of analytical work involved in the inspection of fertilizers is very great and because of the large business interests that are affected by the report of this inspection, it is essential that the analyses be reliable beyond question. So great is the necessity for entirely trustworthy laboratory data, the Station has adopted the policy of entrusting this work largely to men of experience at salaries that shall tend to secure their services permanently, rather than to employ mostly assistants of a lower grade, and at small salaries, whose results would be less satisfactory even with constant supervision, and who would constantly be changing to more lucrative positions.

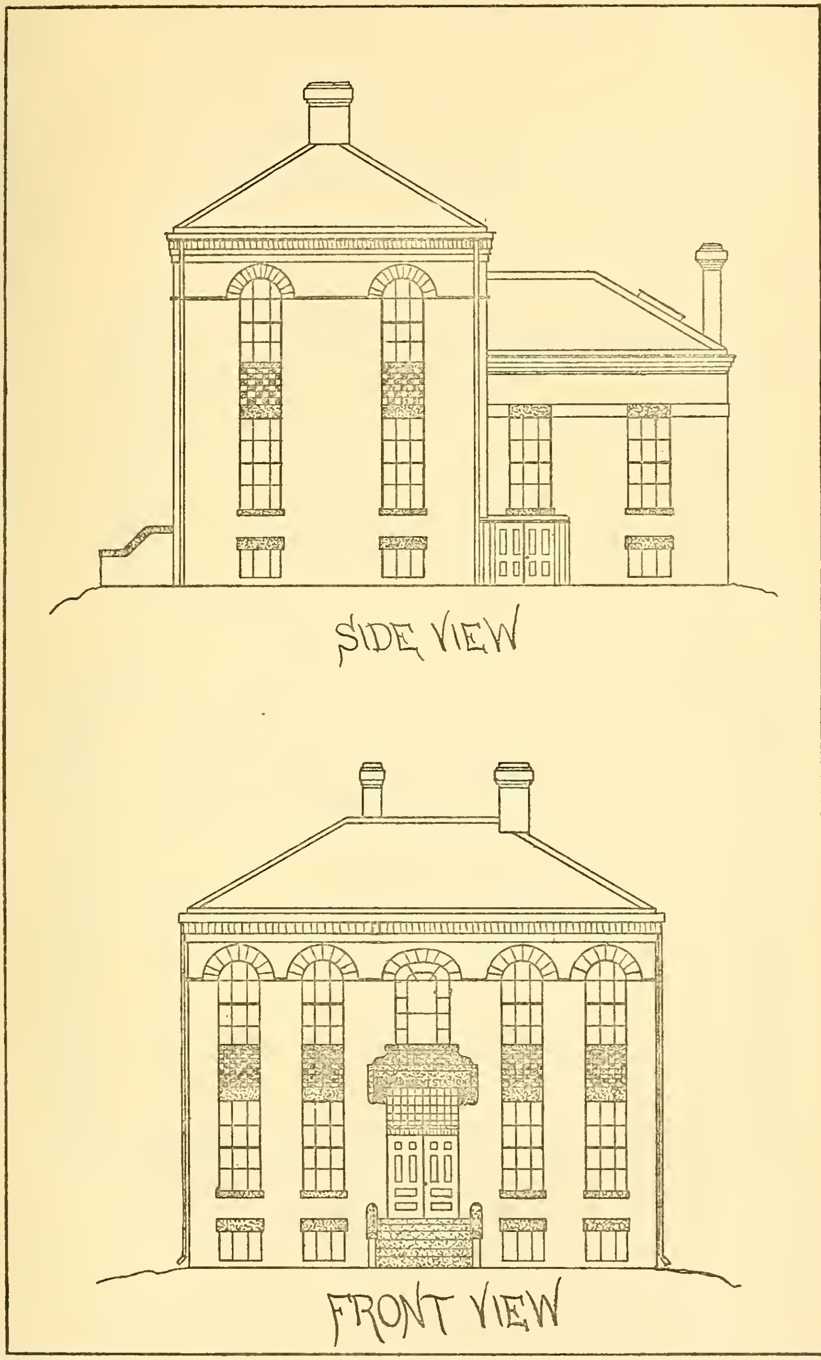
(*9*) An important part of the conduct of field and feeding experiments is the immediate supervision of the details of their execution. An experiment may involve ever so interesting a problem, and may be ever so wisely planned, but unless it is carried out with good judgment and fidelity on the part of the one who attends to its actual execution, it is likely to be worse than useless. It is no easy thing to exercise the care necessary to correctness in weights and records, when several experiments are being carried on at the same time. These duties now devolve upon Mr. Shaw, foreman on the farm, who has rendered the Station efficient service in this direction.

The work of the Station, as outlined above, covers a wide field of inquiry, and it should not be expected that all the problems important in Maine agriculture will receive attention at once, or that these problems will be quickly solved. Many points in farm practice must be studied experimentally for several years, before safe conclusions can be reached, although some questions can be answered in less time. An effort will be made to adapt the work of the Station to the special needs of the State, and to secure results whose direct practical value shall be unquestioned.

STATION BUILDINGS AND APPLIANCES.

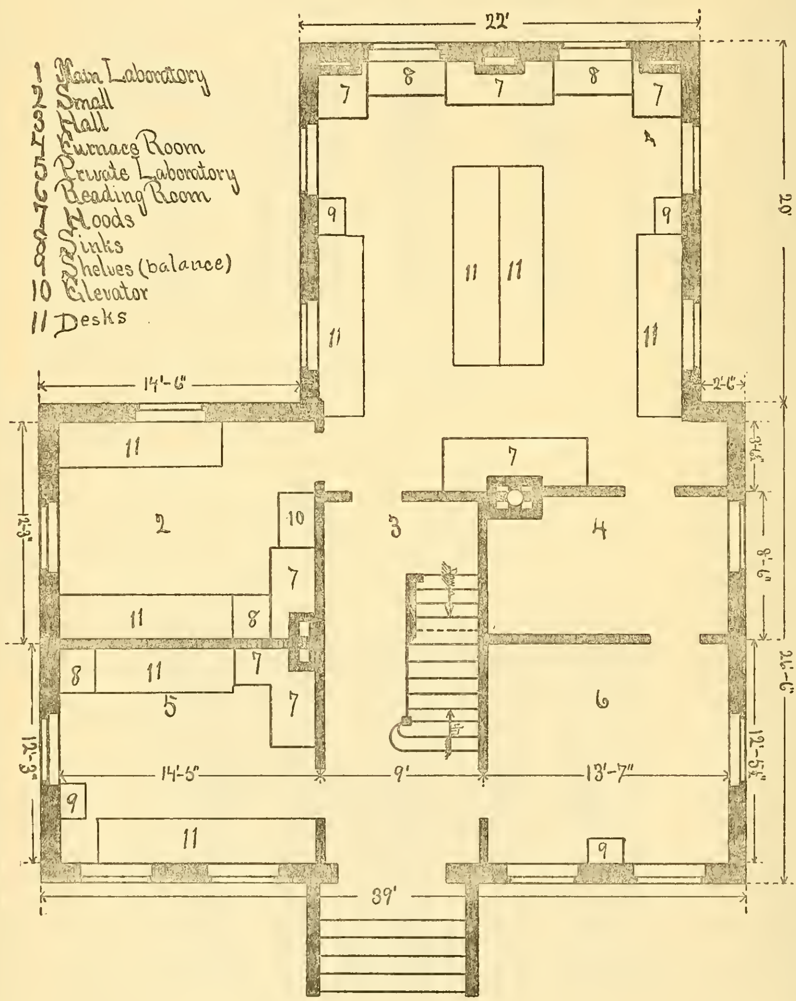
Since the first organization of an experiment station at the college in 1885, it has occupied building space that has been needed by the departments of instruction. Moreover, now that national aid has so greatly enlarged the scope of the work to be done, the demand for more and better room for laboratory and other purposes has become imperative. This fact was recognized by the trustees at the February meeting of 1887, and consequently they made arrangements for the erection of a building to contain the chemical laboratory, station office and director's room. This building, constructed of brick with granite trimmings, is now nearly ready for occupancy, and is believed to be well suited to the work for which it is intended. Its general appearance and plan are shown by the accompanying plates.

The basement contains space for the unpacking and storage of apparatus and chemicals, a Springfield gas machine for the manufacture of burning gas from naphtha, a boiler which supplies steam for heating and laboratory purposes, and room for coal. On the first floor are five rooms devoted entirely to chemical work, including a reading room in which is to be placed a special chemical library. Three of these rooms are furnished with gas, water, tables, hoods, steam baths for evaporation and balance shelves set on brackets built into the wall. The apparatus for these rooms is already purchased. The upper floor has a Station office with an accompanying small room for storage, the director's private room, and a room which will probably be temporarily devoted to bacteriological investigations. The whole building is heated by steam and lighted by gas. In the office has been placed a large Hall's safe for the preservation of the records, a National Files Cabinet for the systematic filing of letters and papers, and a large case for the proper storage and distribution of pamphlets, bulletins, etc.

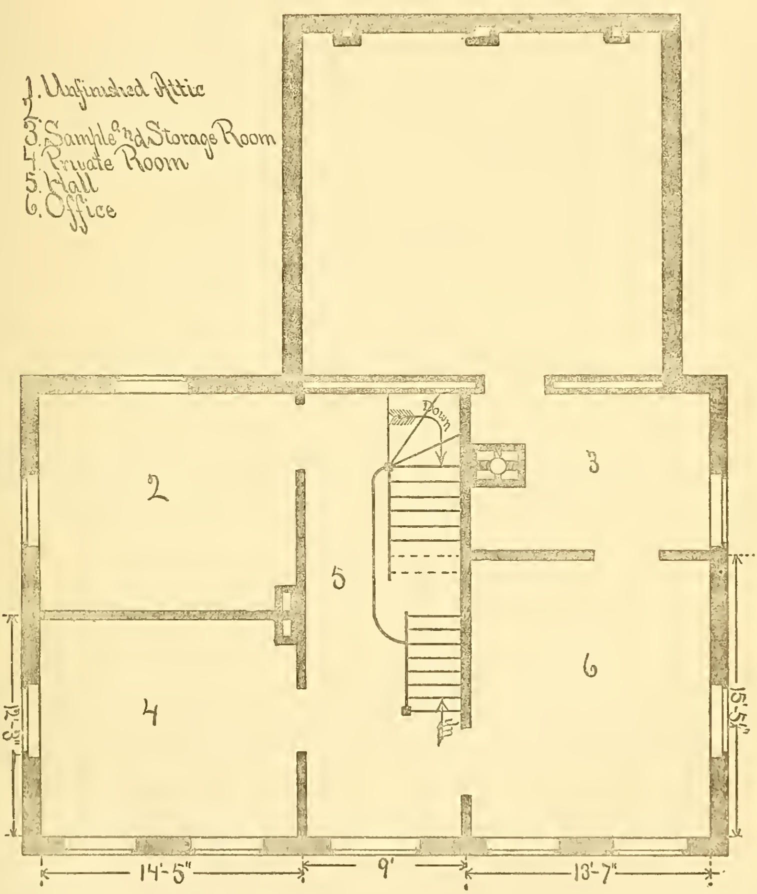


AGRICULTURAL EXPERIMENT STATION BUILDING, MAINE STATE COLLEGE.

FIRST FLOOR PLAN



SECOND FLOOR PLAN



The whole building is to be equipped so thoroughly, that with a given force the maximum amount of work will be accomplished.

The experiments with live stock have been carried on so far in the barn that will be needed for other purposes as soon as the college farm is restocked, and space for this work must be provided elsewhere. If in some way funds can be secured to complete the outside of the unfinished new barn, the amount allowed from the national appropriation will probably be sufficient to fit the inside for feeding and dairy experiments, and to build the dairy room that must be provided when the one belonging to the farm is again occupied. Such an arrangement seems to be the only possible one that will adequately provide for the experimental work which the station proposes to do.

Land necessary for field experiments has been set aside from the college farm, and is already occupied, and the field experiments to which it is devoted include the use of small plots for fertilizer tests and tests of varieties, and of large areas on which different systems of crop production will be practiced for a series of years.

As a means of conducting feeding and dairy experiments, the station has purchased eight thoroughbred cows (two each of the Jerseys, Ayrshires, Holsteins and Shorthorns), six thoroughbred steers (two each of the Herefords, Holsteins and Shorthorns), twelve pigs and six sheep, also the necessary scales for weighing animals, rations and milk, and an outfit of dairy apparatus.

THE CONTENTS OF THIS REPORT.

This report contains the results of a comparatively small amount of experimental work, for reasons previously given. It is quite largely devoted to matters of an explanatory and informational character. For instance, under the head of foods, quite an amount of space is occupied by explanations in regard to the composition and digestibility of cattle foods, and the basis, value and use of the German feeding standards, and these subjects have been treated at so much length in response to a direct call for such information. It is proposed to treat other subjects in a similar manner, so that the Station Reports may serve as books of reference. It will be noticed, also, that the main part of the matter given in the bulletins published in 1888, is reprinted here.

Quite a number of experiments are either under way or are definitely arranged, as can be seen by the following summary of what has been done, or is already undertaken, and some results have been secured which are not published here.

EXPERIMENTS AND INVESTIGATIONS, THE RESULTS OF WHICH ARE ALREADY PUBLISHED.

1. *Wood Ashes.*

Object: The determination of the composition of ashes from different woods, and of those burned and kept under different conditions.

Plan: The collection and analyses of ashes from as many sources as possible.

Time: Summer of 1885.

Results published: Report M. E S., 1885–6, pp. 29–34.

2. *Manure Residue.*

Object: The determination of the value of manure residue from corn meal and cotton seed meal.

Plan: The feeding of corn meal and cotton seed meal with same amount of some kind of hay, and collection and analysis of fæces and urine during the two periods.

Time: Fall and winter of 1885–6.

Results published: Report M. E. S.,* 1885 6, pp. 42–46.

3. *Digestion Experiment.*

Object: To determine digestibility of timothy hay.

Plan: Timothy hay fed to a sheep, with corn meal or cotton seed meal, for twelve days, fæces collected for last five days. Digestibility of meal assumed from German averages. The feeding was carried on for three periods, of twelve days each.

Time: Fall and winter, 1885–6.

Results published: Report M. E. S., 1885–6, pp. 35–58.

(*4*) *Digestion Experiment.*

Object: Digestibility of maize kernel fed in different forms.

Plan: Weighed quantities of whole corn, corn meal and corn and cob meal fed to pig, each for twelve days, and fœces collected for last five. Three periods.

Time: Winter, 1885–6.

Results Published: Report M. E. S., 1885-6, pp. 59-64.

(*5*) *Feeding Experiment.*

Object: The advantage of combining cotton seed meal with corn meal in moderate grain ration fed to milch cows.

Plan: The feeding of same weights of food in three different periods, in first and third periods the grain ration being a mixture

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*M. E. S., for Maine Experiment Station.

of cotton seed meal and corn meal, and in second period pure corn meal. Three cows used in the experiment, each period of feeding being four weeks. During the last two weeks of each period a record was kept of the milk produced, and of the cream and butter, the milk being analyzed also.

Time: Winter, 1885-6.

Results published: Report M. E. S., 1885-6, pp. 65-72.

(*6*) *Feeding Experiment.*

Object: Comparison of wheat straw and a nitrogenous grain ration with timothy hay and corn meal, as food for growing steers.

Plan: Two lots steers, two in each lot, same weights of hay and straw fed, and same weights of grain, only the lot eating straw received some cotton seed in place of part of corn meal fed to lot eating timothy.

Time: Winter, 1885-6.

Results published: Report M. E. S., 1885-6, pp. 73-76.

(*7*) *Field Experiment.*

Object: The practical effect of different forms of phosphoric acid in crop production, also of a complete commercial fertilizer against yard manure.

Plan: Three plots in series manured with each form of P2 O5, accompanied by a sufficient supply of ammonia and potash salts alone, three plots with no manure and three plots with yard manure.

Time: Spring, 1885.

Results published (first year): Report M. E. S., 1886-7, pp. 41-49.

(*8*) *Field Experiment.*

Object: The use of partial as compared with complete fertilizer. The profitable quantity of fertilizers to use.

Plan: Similar to experiment seven.

Time: Spring, 1885.

Results published: First year Report M. E. S. 1886-7, pp. 47-49

(*9*) *Field Experiments.*

Object: To stimulate habits of inquiry and observation. To render farmers more familiar with the composition of fertilizers. To add something if possible, to our stock of knowledge in regard to the profitable use of commercial fertilizers.

Plan: The sending to farmers bags containing different mixtures of fertilizing material with directions for making experiments. The various combinations were P2 O5 alone, P2 O5 and K2 O, and P2 O5, K2 O and N.

Time: Spring, 1886.

Results published: First year, Report M. E. S., 1886-7, pp. 49-64; second year, this report.

(*10*) *Digestion Experiment.*

Object: Digestibility of Timothy hay.

Plan: Seven hundred grams hay fed to a sheep for twelve days, fæces collected for last five days. Fæces and food analyzed.

Time: Fall, 1886.

Results published: Report M. E. S., 1886-7, pp. 72-73.

(*11*) *Digestion Experiment.*

Object: Digestibility of clover hay.

Plan: Same as experiment 10, only 700 grams clover hay fed.

Time: Fall of 1886-7.

Results published: Report M. E. S., 1886-7, pp. 74-75.

(*12*) *Digestion Experiment.*

Object: Digestibility of oat straw.

Plan, same as experiment 10 and 11, only 350 grams oat straw fed daily.

Time: Fall of 1886-7.

Results published: Report M. E. S., 1886-7, pp. 75-76.

(*13*) *Digestion Experiment.*

Object: Digestibility of potatoes, both raw and boiled.

Plan: Three hundred and fifty grams oat straw used in experiment 12 and 1000 grams raw potatoes fed to two sheep for twelve days, fæces collected last five days. Digestibility of straw assumed to be as found in experiment 12; 300 grams Timothy used in experiment 10, and 1000 grams boiled potatoes fed to one sheep for twelve days.

Time: Winter, 1887.

Results published: Report M. E. S., 1886-7, pp. 47-79.

(*14*) *Feeding Experiment.*

Object: Same as experiment No. 5.

Plan: Four cows used in experiment and in each period two cows received Timothy and two clover hay, otherwise plan same as experiment No. 5.

Time: Winter 1886-7.

Results published: Report M. E. S., 1886-7, pp. 84-89.

(*15*) *Feeding Experiment.*

Object: The profitable quantity of food and the profitable combination of foods, in feeding steers for growth.

Plan: Ten steers about eighteen months old, divided into five lots.

Lot 1. Maintenance ration, hay.

Lot 2. Ration for moderate growth, hay and corn meal.

Lot 3. Ration for moderate growth, hay, corn meal and cotton seed meal.

Lot 4. Ration for rapid growth, hay, corn meal and cotton seed meal.

Lot 5. Straw substituted for hay.

Time: Fall and winter, 1886-7.

Results published: Report M. E. S., 1886-7, pp. 89-93.

(*16*) *Feeding Experiment.*

Object: The comparative value of whole corn and corn meal for feeding hogs.

Plan: Two lots of pigs, three in each lot; first period lot 1 fed whole corn, lot 2 fed same weight corn meal; second period lot 1 fed corn meal; lot 2 fed whole corn. In each period same quantity of potatoes and skimmed milk fed each lot.

Time: Fall and winter, 1886-7.

Results published: Report M. E. S., 1886-7, pp. 97-99.

(*17*) *Feeding Experiment.*

Object: The comparative feeding value of corn meal and corn-and cob meal for hogs.

Plan: The feeding of two lots of pigs, three in each lot; lot 3 received corn meal, potatoes and milk, and lot 4, a weight of corn-cob meal containing same amount of kernel as the pure meal of lot 3, and same amount of potatoes and milk.

Time: Winter of 1887.

Results published: Report M. E. S , 1886–7, pp. 99, 100.

(*18*) *Feeding Experiment.*

Object: The relative feeding value of raw and boiled potatoes.

Plan: Two lots, of three pigs each, to be fed in same weights of potatoes, corn meal and skimmed milk, only with one lot the potatoes to be boiled before feeding.

Time: Winter of 1886–7.

Results published: Report M. E. S., 1886–7, pp. 100, 101.

(*19*) *Feeding Experiment.*

Object: The profitable composition of rations for growing poultry.

Plan: The feeding of a pure corn ration against a ration consisting of a mixture of corn and some highly nitrogenous material. Two lots of cockerels, of twelve each.

Time: Fall, 1886.

Results published: Report M. E. S., 1886–7, pp. 101–104.

(20) *Dairy Experiment.*

Object: The effect of varying temperature at which milk is set for cream raising. (1) Upon volume of cream. (2) Upon composition of cream. (3) Upon quantity of cream to each pound of butter. (4) Upon fat left in skimmed milk. Other minor points are considered.

Plan: The setting of equal weights of same milk at different temperature, the milk, cream and skimmed milk to be analyzed, and the cream and butter weighed.

Time: Spring and summer, 1887.

Results published: Report M. E. S., 1886–7, pp. 107–119.

(21) *Available Nitrogen.*

Object: Relative value of organic nitrogen in different fertilizers.

Plan: Treatment of fertilizers with an artificial pepsin solution, and determination of undissolved nitrogen.

Time: Spring, 1887.

Results published: Report M. E. S., 1886–7, pp. 124–126.

(22) *Digestion Methods.*

Object: The comparison of artificial digestion of protein, with results obtained by experiments with animals; also errors for protein of natural method.

Plan: Treatment of foods used in digestion experiments with animals with artificial solutions of pepsin and pancreas, and treatment of fæces with such solvents as will remove the "stoff-wechsel producte," and not act upon the undigested food residue.

Time: Fall and winter 1886-7.

Results published: Report M. E. S., 1886-7, pp. 127-135, and this report.

(23) *Test of Varieties.*

Object: Test of comparative value of different varieties of oats.

Plan: The sowing of equal areas with the different varieties under similar conditions, the main facts of growth, yield and bushel weight to be recorded.

Time: Spring 1886.

Results published: First year, Report M. E. S 1886-7, pp. 105-6; second year, this report.

(*24*) *Test of Varieties.*

Object: Test of comparative value of different varieties of barley.

Plan: Same as experiment No. 23.

Time: Spring 1886.

Results published: First year, Report M. E. S., 1886-7, p. 106; second year, this report.

(*25*) *Test of Varieties.*

Object: Test of comparative value of different varieties of potatoes.

Plan: The planting of equal number of hills seeded alike, under similar conditions with record of growth and yield.

Time: Spring, 1886.

Results published: First year, M. E. S., 1886-7, pp. 104-105. Second year, this report.

(*26*) *Digestion Experiment.*

Object: Determination of composition and digestibility of different species of grasses and other forage plants.

Plan: Collected at same stage of growth, subsequent analysis and digestion experiments.

Time: 1887.

Results published: First year, this report.

(*27*) *Culture Experiment.*

Object: The effect of hilling potatoes as compared with flat culture.

Plan: The cultivation of equal areas of potatoes under similar conditions, only certain plots hilled, and certain plots given flat culture, to be tried with both deep aud shallow planting.

Time: Summer, 1887.

Results published: This report.

(*28*) *Feeding Experiment.*

Object: See experiment No. 16.

Plan: See experiment No. 16.

Time: Summer, 1887.

(*29*) *Feeding Experiment.*

Object: The economy of feeding grain to growing steers while at pasture.

Plan: The feeding of two lots of steers, one on grass alone and the other on grass and corn meal, the rations to be alternated between the two lots.

Time: Summer, 1887 (Failure).

EXPERIMENTS OR INVESTIGATIONS ALREADY UNDERTAKEN OR PLANNED.

(30) *Study of Breeds.*

Object: A study of the characteristics and economy of different breeds of cows for dairy purposes.

Plan: The use of four breeds, two cows of each, Holstein, Shorthorn, Ayrshire and Jersey, a record of the amount and composition of foods, the weight and composition of milk, weight and composition of cream, and weights of butter; also a study of physical characteristics of milk and chemical and physical properties of butter.

Time: 1888, and continuing.

(31) *Study of Breeds.*

Object: Study of relative production of beef with different breeds.

Plan: The use of three breeds, two steers of each, Hereford, Shorthorn and Holstein, to be grown from calves under similar conditions and feeding.

Time: 1888, and continuing.

(32) *Feeding Experiment.*

Object: The economical composition of a ration for beef production.

Plan: The dividing of steers used in experiment 31 into two lots, one steer of each breed in each lot, one lot to be fed a ration such as can be compounded without the purchase of highly nitrogenous foods, the other to receive an equal weight of food containing a certain proportion of cotton seed meal (or linseed).

Time: 1888, and continuing.

(33.) *Fodder Investigation.*

Object: A study of the relative feeding value of Timothy, cut at different stages of growth.

Plan: Determination of weights, composition, digestibility and growth produced, of Timothy from plots cut at different stages of growth. Piece divided into six plots, three cut when in bloom, and three cut about two weeks later.

Time: 1888.

(*34.*) *Fodder Investigation.*

Object: The relative amounts and composition of dry matter produced by different varieties of corn grain for ensilage.

Plan: The growing of the different varieties of corn on equal areas under similar condition of soil, manuring and cultivation. Two acres divided into twelve equal plots, four plots being planted to each variety of corn, southern white, common field corn and sweet corn.

Time: 1888.

(*35.*) *Feeding Experiment.*

Object: The feeding value of ensilage as compared with hay.

Plan: The feeding to milch cows and growing steers the same amounts of digestible material in ensilage and hay. The other parts of the ration being alike.

Time: Fall and winter 1888-9.

(*36*) *Feeding Experiment.*

Object: The determination of the actual maintenance ration.

Plan: Feeding steers with hays, record to be kept of weight and composition of foods fed, change in weights of animals, and weights and composition of excretions.

(*37*) *Feeding Experiment.*

Object: The relative value of skimmed milk and corn meal as foods for growing swine.

Plan: The feeding to two lots of pigs, of two animals each, the same amounts of digestible material, to come more largely from skimmed milk than in the other, a small amount of bone meal to be fed to each lot. Pigs from same litter.

Time: 1888.

(*38*) *Feeding Experiment.*

Object: The effect of a large amount of drink on the growth of pigs.

Plan: The feeding to two lots of pigs, of two each, the same amounts of digestible material, in one case the amount of drink to satisfy the thirst of the animal, and in the other the animal to be induced to drink more than necessary.

(*39*) *Feeding Experiment.*

Object: The use of nitrogenous foods in the growing of pigs.

Plan : The feeding of two lots of pigs on same amounts of digestible material, the ration to be more nitrogenous in one case than in the other, drink and all other conditions to be similar.

(*40*) *Fertilizer Pot Experiment.*

Object: The study of the availability of different forms of phosphoric acid.

Plan: The growing of plants in sand, different plots being manured with different forms of $P_2 O_5$, all other elements of plant food being supplied in abundance, and conditions of temperature, moisture, being the same for all plots. Galvanized iron pots used.

Time: 1888.

(*41*) *Fertilizer Box Experiment.*

Object; Same as No. 40.

Plan: Same as No. 40, only plants grown in boxes three feet square, set ground, no bottoms, and filled with ordinary soil.

Time: 1888.

(*42*) *Fertilizer Box Experiment.*

Object: A study of the availability for plant growth of different forms of nitrogenous material.

Plan: Same as No. 41.

Time: 1888.

ACKNOWLEDGEMENTS.

The publishers of the following named papers have kindly placed this station upon their complimentary list, for which grateful acknowledgement is hereby made:

American Analyst, 19 Park Place, N. Y.; American Cultivator, Boston, Mass.; American Grange Bulletin, Cincinnati, Ohio; American Rural Home, Rochester, N. Y.; Delaware Farm Home, Wilmington, Del.; Eastern Farmer, Waterville, Me.; Farmers' Advocate, London, Ont.; Farmers' Club Journal, Hornellsville, N. Y.; Farm and Fireside, Phila., Pa.; Farm and Home, Springfield, Mass.; Farmer's Home, Dayton, Ohio; Farm Journal, Phila., Pa.; Farmers' Review, Chicago, Ill.; Hoard's Dairyman, Fort Atkinson, Wis.; Jersey Bulletin, Indianapolis, Ind; Mirror and Farmer, Manchester, N. H.; Maine Farmer, Augusta, Maine; Massachusetts Ploughman, Boston, Mass.; National Farmer, Augusta, Maine; New England Farmer, Boston, Mass.; New York Weekly Tribune, New York, N. Y.; Ohio Farmer, Cleveland,

Ohio; Orange County Farmer, Port Jervis, N. Y.; Philadelphia Weekly Press, Phila., Pa.; Practical Farmer, Phila, Pa.; Southern Cultivator, Atlanta, Ga.; The Husbandman, Elmira, N. Y.

Lewis & Cowles of Catskill, N. Y, very generously presented the Station with a Lewis Combination Force Pump, some account of the use of which is given in this report by Prof. Harvey. Thanks are also due to Hon. E. E. Parkhurst of Maysville Center, Me., for the present of a thorough-bred short horn bull calf. Several fertilizer manufacturers have very kindly offered to supply the Station with quantities of their goods, sufficient for field experiments, but the offers have been declined for obvious reasons.

W. H. JORDAN,
Director.

MAINE STATE COLLEGE,
AGRICULTURAL EXPERIMENT STATION,
Orono, Maine, Jan. 1st, 1889.

FERTILIZERS.

INSPECTION OF FERTILIZERS.*

The inspection of the various brands of fertilizers sold in the State has for its object (1) the comparison of the actual composition of these brands with the guaranteed composition, this being required by law, and (2) the determination of their relative values. In carrying out this inspection the fertilizers must be sampled in the hands of dealers or consumers, analyzed, and their values then calculated on the basis of ruling commercial prices.

There are given below the history, analyses and valuations of eighty-five samples, taken from thirty-eight brands, with such preceding explanations as are deemed necessary for a clear understanding of the main facts pertaining to the composition of commercial fertilizers, and of the real significance that the analyses and valuations have for the consumer.†

VALUABLE INGREDIENTS OF FERTILIZERS. The ingredients of commercial fertilizers upon which both their agricultural and commercial values chiefly depend are nitrogen, phosphoric acid and potash. Besides these more valuable ingredients, sulphuric acid and lime are always present in superphosphates in considerable quantities, being a necessary accompaniment of phosphoric acid as it exists in nearly all manufactured fertilizers. Fertilizers also contain soda, magnesia, iron, alumina, chlorine, silica and more or less organic matter, the number and quanitity of the ingredients varying according to the raw materials used

Nitrogen is the most costly of the three important ingredients mentioned, and adds largely to the commercial value of all the fertilizers sold in Maine, with a few exceptions. It is found in the markets in quite a variety of substances which are used by manufacturers to supply this ingredient to mixed fertilizers, but which are available for fertilizing purposes when purchased unmixed with anything else.

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*The explanations in regard to the composition and valuation of fertilizers which are made under this head are mainly reprinted from the previous reports of the Station, with such changes as are necessary. The apology for quoting so largely from a previous report, is that there are no new facts to be stated, and that to express the old facts in a new form would probably not add anything in value or clearness to the explanations already made. These explanations will not be repeated in further reports, so that those who receive this report will do well to preserve it for future reference.

†Previously printed in bulletins 23 and 25.

Nitrate of soda, a compound of nitric acid (aqua fortis) and soda, and sulphate of ammonia, a compound of sulphuric acid (oil of vitriol) and ammonia, are two of the most valuable nitrogenous materials which are used to supply nitrogen to the farmer. Their nitrogen is immediately available for use by the plant, the nitric acid of the one and the ammonia of the other being the compounds of nitrogen which largely serve as plant-food.

The following materials furnish organic nitrogen to fertilizers:

Dried blood, dried and ground fish, azotin and ammonite (prepared animal matter), fish scrap, meat scrap, cotton-seed meal, castor pomace, horn, hair, wool, leather waste, etc. These substances must decompose and the nitrogen become changed into compounds of nitric acid and ammonia before it is largely available to plants. There is, therefore, a great difference in the value of organic nitrogen as found in the above-named materials. Dried blood, for instance, decomposes in the soil rapidly, while horn, hair, wool and leather scrap in their natural condition decay very slowly, and the nitrogen which they contain becomes useful only after a long period of time. These latter substances are not only less useful to the farmer than blood, fish and meat, but they are also much less costly, and their presence in a fertilizer supposed to be manufactured of the best materials is good evidence of fraud. It is now possible to determine whether organic nitrogen of so poor a quality is largely used in any fertilizer.

The phosphoric acid of superphosphates is determined in three forms, according to its solubility in various liquids, viz: *soluble*, *reverted* and *insoluble*.

Soluble phosphoric acid is that which exists in fertilizers in a form freely soluble in water. It is obtained by treating certain phosphatic materials, such as bone and South Carolina rock, with sulphuric acid (oil of vitriol.)

In the chemical changes caused by the sulphuric acid, besides the production of a soluble calcium phosphate, with perhaps some free phosphoric acid, hydrated calcium sulphate (gypsum) is formed if sufficient water be present, which is the same compound as land plaster. The advantage of having the phosphoric acid of fertilizers rendered soluble is not that it remains so in the soil, for it becomes insoluble in water very shortly after application, but in the fact that when the compounds of the soil change it back to an insoluble condition it becomes deposited in particles so minute that they are easily appropriated by the roots of plants.

Reverted phosphoric acid is a term originally signifying phosphoric acid that has once been "soluble," but which from some cause has "reverted" or "gone back" to forms insoluble in water. Now it is used to designate that which is dissolved by a solution of ammonium citrate, and includes not only the truly reverted, but also more or less of phosphoric acid as combined in the original, undissolved phosphatic material. Reverted phosphoric acid, in so far as it comes within the strict meaning of the term, most probably has a value for crop production equal to that of the soluble form, but it is not clear that this holds true of that which would be dissolved by ammonium citrate from finely ground South Carolina rock, for instance, at a temperature of 65° C.

Insoluble phosphoric acid is that which is readily soluble neither in water nor in a solution of ammonium citrate, but which can be dissolved in strong acids. In superphosphate it comes from some of the original phosphatic material that has not been acted upon by sulphuric acid, and depends somewhat for its value upon the kind of material used, whether bone or rock phosphate. In any case it has less value than the soluble or reverted forms.

It should be remembered that the terms "soluble," "reverted," and "insoluble" are merely relative in their significance. There is no compound of phosphoric acid that is not dissolved to a slight extent, at least, by pure water, and to a still greater degree by ammonium citrate, and the extent of the solubility of raw phosphates in these liquids, and in weak acids such as are found in the roots of plants, depends very largely upon their mechanical condition, or the degree of fineness to which they are ground.

The *potash* used in this country for agricultural purposes comes mostly from Germany in the so-called "German potash salts," which include potassium sulphate, potassium chloride (the muriate) and kainite. Except for a few special purposes, potash is equally valuable in all these forms, but costs least in the muriatic and in kainite.

All fertilizers contain more or less *water*. The presence of this ingredient does not affect the actual value of a fertilizer unless it is in sufficient quantity to cause stickiness and thus render it difficult to distribute the fertilizer uniformly by hand, or by a corn planter or other machine. That is to say, two fertilizers containing the same quantities of the same kinds of plant-food will be equally valuable, no matter whether the amount of water present is the same or not, provided, as stated, there is not enough in either fertilizer to induce a bad mechanical condition.

THE VALUATION OF FERTILIZERS.

The law regulating the sale and analysis requires that the average of three analyses of each brand of fertilizer sold in the State, shall be compared with the guaranteed composition of the fertilizers examined.

This Station, in common with all American experiment Stations that stand in an official relation to the fertilizer trade, goes farther than this and applies a schedule of trade values to the goods that it inspects. By means of these trade values there is calculated for each brand what has been designated as the "estimated value" or the "station valuation." As these estimated values are not intended to represent the proper selling price of mixed goods at the point of consumption, and in order to prevent any possible misapprehension as to their real meaning, the following explanations are offered:

1. These trade values represent very closely the prices at which a pound of nitrogen, phosphoric acid and potash, in their various forms, can now be purchased for cash at retail in our large markets. They are based mostly upon the ton prices at which certain classes of goods are offered to actual consumers, and correspond also to "the average wholesale prices for the six months ending March 1st, plus about twenty per cent. in the case of those goods for which we have wholesale quotations."

2. These trade values do not include the charges for transportation from the market to the consumer, for storage, mixing, selling on long credit, bad debts, etc., etc.

3. They are the prices of nitrogen, phosphoric acid and potash, *ready for use by the farmer*, when these ingredients are purchased under the above-named conditions, singly and not mixed. In ordinary superphosphates we find these three ingredients mixed, but this is not a necessary condition of their use.

An illustration may serve to make clear the above statements. A farmer wishes a ton of fertilizer similar to the well-known brands sold in this State. If he purchases for cash in New York or Boston sixteen hundred (1,600) pounds of dissolved bone black, three hundred (300) pounds of sulphate of ammonia, and one hundred

(100) pounds of muriate of potash, and mixes these ingredients together, he will have a complete fertilizer not essentially different from many standard brands of ammoniated superphosphates. The cost of the ton after mixing (if the farmer prefers to mix the ingredients) will be made up as follows:

a. Cost of materials in the markets.

b. Cost of transportation.

c. Cost of mixing.

The first element entering into the total cost is the only one included in the "estimated value." If there is added to this one element not only the charges for transportation and mixing, but also the expenses of selling through agents and dealers, long credits, bad debts, etc., we have the factors involved in the cost of our ordinary superphosphates when delivered at or near the place of consumption. As is to be expected, the Station valuations of superphosphates fall below their selling prices. In 1886 the average difference in this State was $9.96 per ton, and in 1887 it was $8.00 per ton, excluding certain brands for which there is evidently a serious overcharge.

4. The Station valuations stand in no direct or necessary relation to the comparative profits which may be derived from the use of the various fertilizers by individual farmers. These values have an almost purely commercial significance, and are not designed to point out to a farmer whether he shall use potash, which is a comparatively cheap ingredient, or nitrogen, which is comparatively costly. For instance, if a farmer finds that he needs to use potash he can buy it for less than five cents per pound; but if an artificial supply of nitrogen is necessary to successful crop production on his soil he must pay nearly twenty cents per pound for the best forms of this ingredient. The success or failure of a particular kind of fertilizer in some special locality has no bearing on the cost of the materials entering into its manufacture. If ordinary superphosphates are compared, however, on the basis of commercial valuations it will generally be found to be true, that their fertilizing power under conditions favorable to their use, is in proportion to the money value.

The following schedule of trade values used in this State for 1888 is the one agreed upon by the experiment Stations of Massachu setts, Connecticut and New Jersey, after a careful study of prices ruling in the large markets of New England and the Middle States.

For comparison, the trade values used in 1886 and in 1887 are also given :

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals for 1888.

	1886. Cts. per lb.	1887. Cts. per lb.	1888. Cts. per lb.
Nitrogen in ammonia salts	18½	17½	17½
" in nitrates	18½	16	16
Organic nitrogen in dried and fine ground fish,	17	17½	16½
" in azotin, ammonite and dried and ground meat	17	16½	16½
" in cotton seed, linseed meal and in castor pomace	17	17½	16½
" in dried and fine ground blood		16½	16½
" in fine ground bone	17	16	16½
" in fine medium bone	15	14	13
" in medium bone	13	12	10½
" in coarse medium bone	11		8½
" " horn shavings, " " hair and fish " " scrap	9	8	8
Phosphoric acid, soluble in water	8	8	8
" " " in ammonium citrate (commonly called "reverted")	7½	7½	7½
" " insoluble, in dry fine ground fish and in fine bone	7	7	7
" " insoluble, in fine medium bone	6	6	6
" " " in medium bone	5	5	5
" " " in coarse medium bone	4	4 }	4
" " " in coarse bone	3	3 }	
" " " in fine ground rock phosphate	2	2	2
Potash as high grade sulphate	5½	5½	5½
" kainite	4¼	5¼	4¼
" muriate	4¼	4¼	4¼

It is seen that the prices for 1888 are practically the same as those for 1887.

These values are applied to the valuation of Superphosphates and all mixed goods, as follows :

It is assumed that the organic nitrogen of these goods has for its source such materials as dried blood, ground fish, or nitrogenous substances of equally good quality, unless a special examination of some particular brand shows that inferior material like leather has been used. Organic nitrogen in mixed goods is therefore valued at sixteen and one-half cents per pound. The nitrogen present in nitrates and ammonia salts is reckoned at 16 cents and 17½ cents respectively.

The insoluble phosphoric acid of mixed fertilizers is considered as coming entirely from bone, and not from South Carolina rock, and is reckoned at three cents per pound.

The potash is valued at the price of that ingredient in kainite and the muriate, unless the chlorine present in the fertilizer is not sufficient to combine with it, in which case the excess of potash is reckoned as the sulphate.

The valuation of a fertilizer is obtained by multiplying the percentages of the several ingredients by twenty (which gives the pounds per ton), and these products by the prices per pound, and the sum of the several final products is the market value of the fertilizing ingredients in one ton.

These estimated values should be studied in the light of the previous explanations. It will probably rarely happen in this State that a mixed fertilizer can be sold near the point of consumption as low as the Station valuation, the excess of cost representing certain expenses previously enumerated. The station valuations give the consumer a fairly accurate basis for estimating the relative cost of plant-food in the various brands of fertilizers, and will help the farmer to determine whether he can in any way profitably change his methods of buying fertilizing ingredients. A caution should be uttered, however, against making too close an application of the Station valuations, as a difference of a few cents, or even of a dollar, on a ton between two brands may have no real significance, but may be due to unavoidable errors of sampling and analysis, that render it impossible to determine to the utmost exactness the composition of the entire bulk of material that is sold.

On the other hand farmers should be cautioned against the statements of interested parties to the effect that the Station valuations are misleading and are worthless as a guide to the farmer. It is generally accepted that nitrogen, phosphoric acid and potash are the ingredients which determine not only the agricultural, but also the commercial value of a fertilizer. The most searching tests of the chemical methods now in use by official chemists show that these methods are accurate in determining the amounts of these ingredients. How then can it be demonstrated that chemical analysis is unreliable as a means of testing the quality and value of a fertilizer? Manufacturers of fertilizers very generally employ a chemist to test the quality of the raw materials and chemicals which they purchase, and to ascertain the composition of their manufactured goods, and that these business men have confidence in the chemist is shown by the fact that they buy and sell material worth thousands of dollars on the strength of his verdict. It is unreasonable, it is even worse than unreasonable, to claim that the same methods which so efficiently serve the manufacturer are valueless as a means of protection to the consumer. Granting, then, that the analyses are reliable, the valuations are a safe means of determining the *comparative* commercial values of fertilizers, within the limits of accuracy already pointed out.

There are given in this report the analyses of thirty-eight brands of fertilizers, and it is to be noticed that more than half of these brands have "estimated values" that are very nearly alike, the differences being mostly insignificant. On the other hand certain brands have a low comparative valuation, which is more significant from the fact that this year is but a repitition of last year in this respect. The two brands of Common Sense Fertilizers, so called, have a valuation of $15.87 and $12.29 respectively, which is not so good a showing as these brands made last year, and the prices for which they were then offered were $35.00 and $20.00. The fact is, these brands contain only from one-third to one-half as much nitrogen, phosphoric acid and potash as the leading fertilizers sold in the State, and it is perfectly demonstrable that their cost to the manufacturer is in about the same ratio as compared with the best goods. Why then should their selling prices be so out of proportion to their cost?

The tables which immediately follow give the history of the samples taken, and their analyses. The comparative money values, as calculated by the Station in the manner previously explained, have much more significance than the excess of selling price over valuation, because the selling price varies in some instances according to the quantity of fertilizer sold, conditions of payment, location, etc.

There is one point in connection with the excess of selling price, however, to which attention should be called, which is that the same excess of selling price over valuation in two cases does not necessarily mean that one fertilizer is sold as cheaply as the other. This can be illustrated as follows: A's fertilizer is sold for forty dollars per ton, and values at thirty-two dollars. B's fertilizer sells for twenty-four dollars per ton, and has a valuation of sixteen dollars. The excess of selling price is eight dollars in both cases, but this is only twenty-five per cent of the money value of the ingredients in A's fertilizer, while it is fifty per cent of a similar valuation of B's fertilizer. In other words, B is charging the farmers twice as much as A for handling a given quantity of plant-food.

In studying the composition of fertilizers with reference to their use the following points are important:

1. *The relative amounts of the different ingredients*, or what is the same thing, *the relative expenditure for the different ingredients.* It is to be noticed, for instance, that one superphosphate mentioned in these tables contains 14.06 per cent of phosphoric acid, and 2.59 per cent of nitrogen, while another contains 8.35 per cent of phosphoric acid and 5.73 per cent of nitrogen. In the former case the valuation of the fertilizer is $29.14, and of this $18.18 is derived from the phosphoric acid and $8.53 from the nitrogen. In the latter case the total valuation is $32.80, of which the phosphoric acid furnishes $11.44 and the nitrogen $18.70. At whatever price these two fertilizers are bought, in the one case about 62 per cent of the price would be expended for phosphoric acid, and 29 per cent for nitrogen, while in the other case these figures would be nearly reversed, 35 per cent of the cost belonging to the phosphoric acid and 57 per cent to the nitrogen. Whether it is wise for the farmer to make the larger expenditure for phosphoric acid or for nitrogen is determined by his needs, and with this question these analyses and valuations have nothing to do.

2. *The condition of the phosphoric acid, whether largely available or not.* The total phosphoric acid in one of the fertilizers examined this year is 11.17 per cent, of which only .48 per cent, or about one twenty-third is in the insoluble form. In another fertilizer the total phosphoric acid is 18.35 per cent, of which 13.69 per cent, or about three-fourths, is insoluble. This means that the phosphoric acid of one fertilizer is largely available at once, while the other fertilizer will give up this ingredient to plants much more slowly. This is an important matter, and if a market-gardener or sweet

corn grower finds it necessary to decide between the two fertilizers he should not be long in doubt.

Two main considerations, then, should control in the purchase of commercial fertilizers, the composition and the market value. No farmer can afford to purchase material he does not need, and it is equally unwise to pay $35 per ton for a fertilizer whose valuation is only $15.87.

The figures which show the composition of the various fertilizers analyzed represent the pounds of ingredients found in one hundred pounds of the fertilizer.

Tables showing History, Analyses and Valuations of Fertilizers offered for Sale in 1888.

Analyses by J. M. BARTLETT and L. H. MERRILL.

FERTILIZERS.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
360	Allen Fertilizer	American Manufacturing Co., Boston, Mass	Saco	360
372	Americus Amm. Bone Superphosphate	Williams & Clark Co., New York, N. Y.	Biddeford	372
309	" " "	" " " " "	Portland	309
291	" " "	" " " " "	Bangor	291
307	Amm. Bone Superphosphate	Crocker Fertilizer and Chemical Co., Buffalo, N. Y.	Portland	307
385	" "	" " " "	Garland	385
398	" "	" " " "	Hallowell	398
293	Bay State Fertilizer	Clark's Cove Guano Co., New Bedford, Mass.	Bangor	293
313	" " "	" " " "	Portland	313
300	Bay State Superphosphate	J. A. Tucker & Co , Boston, Mass	Augusta	300

FERTILIZER ANALYSES.

Station Number	Brand.	Moisture.	Nitrogen. Found.	Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Phosphoric Acid. Available. Found	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Station valuation of one ton.	Selling price.	Selling price exceeds valuation.	Station Number
360	Allen Fertilizer	7.55	2.35	2.50	6.20	1.54	1.69	9.52	8.00	7.74	6.50	5.75	5.00	$26 14	$37 00	$8 86	360
372	Americus Amm. Bone Superphosphate	11.12	2.80	....	9.31	1.08	.47	10.86	....	10.39	....	3.24	....	29 81	39 00	9 19	372
309	" " " "	13.17	2.76	....	9.78	.54	.46	10.78	....	10.32	....	3.19	....	29 37	38 00	8 63	309
291	" " " "	8.83	2.64	....	9.97	1.38	.50	11.85	....	11.35	....	2.92	....	30 29	36 00	5 71	291
	Average	11.04	2.74	2.88	9.69	1.00	.48	11 17	11.00	10.69	11.00	3.12	2.50	29 83	37 67	7 85	
307	Amm. Bone Superphosphate	12.77	3.22	....	7.42	1.57	2.26	11.25	....	8.99	....	1.54	....	27 50	36 00	8 50	307
385	" " "	11.27	3.12	....	7.72	2.18	1.76	11.66	....	9.90	....	1.68	....	28 42	35 00	6 58	385
298	" " "	11.60	3.39	....	7.34	1.94	1.08	10.36	....	9.28	....	1.84	....	28 04	36 00	7 96	298
	Average	11 88	3.25	3.12	7.50	1.90	1.70	11.09	....	9.39	10.00	1.69	1.08	27 99	35 67	7 68	
293	Bay State Fertilizer	11.49	2.50	....	8.06	2.03	1.98	12.07	....	10.09	....	2.80	....	27 92	36 00	8 08	293
313	" " "	10.37	2.85	....	7.88	2.10	2.59	12.57	....	9.98	....	2.58	....	29 46	36 00	6 54	313
	Average	10.93	2.68	2 88	7.97	2.06	2.79	12.32	....	10.03	11.00	2.69	2.50	28 69	36 00	7 31	
300	Bay State Superphosphate	17.26	2.85	2.75	6.88	1.02	3.09	10.99	11.00	7.90	9.25	2.40	2.50	25 83	35 00	9 17	300

FERTILIZERS.

Station Number	Brand.	Manufacturer.	Sampled at	Station Number.
286	B. D. Sea Fowl Guano	Bradley Fertilizer Co., Boston, Mass	Bangor	286
319	" " "	" "	Lewiston	319
326	" " "	" "	Fairfield	326
324	Bowker's Ammoniated Dissolved Bone	Bowker Fertilizer Co., Boston, Mass	Fairfield	324
380	" "	" "	Wells	380
399	" "	" "	Skowhegan	399
336	Bowker's Hill and Drill Phosphate	" "	Unity	336
368	" "	" "	Biddeford	368
400	" "	" "	Skowhegan	400

FERTILIZER ANALYSES.

Station Number	Brand.	Moisture.	Nitrogen.		Phosphoric Acid.							Potash.		Station valuation of one ton.	Selling price.	Selling price exceeds valuation.	Station number
								Total.		Available.							
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Found.	Guaranteed.	Found.	Guaranteed.	Found.	Guaranteed.				
286	B. D. Sea Fowl Guano	13.05	2.49	.....	8.80	1.05	1.80	11.65	.....	9.85	.....	2.65	.....	$27 18	$34 00	$6 82	286
319	" " "	13.09	2.54	.....	8.64	1.86	2.28	12.78	.....	10.50	.....	1.88	.....	27 94	34 00	6 06	319
326	" " "	12.39	2.66	.....	7.98	2.53	1.94	12.45	.....	10.51	.....	1.67	.....	27 91	34 00	6 09	326
	Average	12.85	2.57	2.87	8.48	1.82	2.01	12.30	12.50	10.29	10.00	2.07	2.50	27 67	34 00	6 33	
324	Bowker's Ammoniated Dissolved Bone	12.80	2.71	.....	8.04	2.29	1.49	11.82	.....	10.33	.....	1.66	.....	27 53	35 00	7 47	324
380	" "	13.98	2.38	.....	7.66	3.25	1.10	12.01	.....	10.91	.....	2.42	.....	27 64	34 00	6 36	380
399	" "	11.33	2.48	.....	7.08	2.15	3.05	12.28	.....	9.23	.....	1.42	.....	25 75	35 00	9 25	399
	Average	12.71	2.53	2.47	7.60	2.57	1.88	12.04	12.00	10.16	11.00	1.84	2.50	26 98	34 67	7 70	
336	Bowker's Hill and Drill Phosphate	13.33	2.97	.....	7.55	2.72	2.02	12.29	.....	10.27	.....	1.87	.....	28 69	36 00	6 59	336
368	" "	13.29	2.76	.....	8.30	2.06	1.80	12.15	.....	10.36	.....	1.37	.....	27 66	40 00	12 34	368
400	" "	9.52	3.10	.....	6.56	2.76	2.20	11.52	.....	9.32	.....	2.06	.....	27 93	36 00	8 07	400
	Average	12.05	2.95	2.87	7.47	2.52	2.01	11.99	12.00	9.99	10.50	1.77	2.50	28 09	37 33	9 24	

FERTILIZERS.

Station Number	Brand.	Manufacturer.	Sampled at	Station Number
301	Bradley's Potato Manure	Bradley Fertilizer Co., Boston, Mass	Portland	301
332	" " "	" " " " "	Belfast	332
378	" " "	" " " " "	Kennebunk	378
318	Bradley's Eureka Fertilizer	Bradley Fertilizer Co., Boston, Mass	Lewiston	318
331	" " "	" " " " "	Belfast	331
395	" " "	" " " " "	Gardiner	395
285	Bradley's X. L. Superphosphate	Bradley Fertilizer Co., Boston, Mass	Bangor	285
294	" " "	" " " " "	Augusta	294
302	" " "	" " " " "	Portland	302

FERTILIZER ANALYSES.

Station Number	Brand.	Moisture.	Nitrogen. Found.	Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Station valuation of one ton.	Selling price.	Selling price exceeds valuation	Station Number
301	Bradley's Potato Manure	11.32	3.07	....	6.56	.82	1.57	8.95	.....	7.38	.....	6.65	.....	$28 45	$36 00	$7 55	301
332	" " "	13.30	2.62	....	7.71	1.48	1.20	10.39	.....	9.19	.....	6.25	.....	29 23	32 00	2 77	332
378	" " "	11.72	2.44	.....	7.89	.98	.90	9.77	.....	8.87	.....	6.37	.....	28 39	34 00	5 61	378
	Average	12.12	2.71	2.90	7.39	1.10	1.23	9.71	9.50	8.48	7.00	6.43	5.50	28 69	34 00	5 31	
318	Bradley's Eureka Fertilizer	3.90	2.28	....	3.57	3.12	5.41	12.10	.....	6.69	.....	3.01	....	23 70	......	......	318
331	" " "	8.00	1.91	.....	3.87	3.02	5.37	12.26	.....	6.89	.....	3.50	.....	23 21	28 00	4 79	331
395	" " "	7.55	2.17	.....	2.33	5.88	3.71	11.92	.....	8.21	.....	3.58	.....	24 96	28 00	3 04	395
	Average	6.49	2.12	2.00	3.26	4.01	4.83	12.10	11.00	7.27	5.50	3.36	.....	23 96	28 00	4 04	
285	Bradley's X. L. Superphosphate	14.97	2.67	.....	8.59	1.43	1.73	11.75	12.50	10.02	10.00	2.28	2.50	27 63	34 00	6 37	285
294	" " "	13.10	2.85	2.90	8.08	2.23	1.86	12.17	.....	10.31	.....	2.08	.....	28 60	36 00	7 40	294
302	" " "	14.41	2.83	.....	7.92	2.[illegible]0	1.82	11.84	....	10.02	.....	2.09	.....	27 98	36 00	8 02	302
	Average	14.16	2.79	2.87	8.20	1.92	1.81	11.92	12.50	10.12	10.00	2.15	2.50	28 07	35 34	7 27	

FERTILIZERS.

Station Number	Brand.	Manufacturer.	Sampled at	Station Number
383	Cleveland Superphosphate	Cleveland Dryer Co., Cleveland, Ohio	Gorham	383
396	" "	" " "	Gardiner	396
402	" "	" " "	Fairfield	402
298	Common Sense Fertilizer No. 2	Common Sense Fertilizer Co., Boston, Mass	Augusta	298
317	" " " "	" " " "	Auburn	317
362	" " " "	" " " "	Saco	362
316	Common Sense Fertilizer Diamond D	Common Sense Fertilizer Co., Boston, Mass	Auburn	316
363	" " " " "	" " " "	Saco	363
288	Cumberland Bone Superphosphate	Cumberland Bone Co., Portland, Maine	Bangor	288
306	" " "	" " "	Portland	306
322	" " "	" " "	Fairfield	322

FERTILIZER ANALYSES.

Station Number	Brand.	Moisture.	Nitrogen. Found.	Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found	Potash. Guaranteed.	Station valuation of one ton.	Selling price.	Selling price exceeds valuation.	Station Number
383	Cleveland Superphosphate	13.94	2.81	.....	7.74	1.93	1.83	11.50	....	9.67	.....	1.95	.....	$27 64	$35 00	7 36	383
396	" "	13.48	2.79	.....	8.12	2.21	1.89	12.22	.....	10.33	.....	2.10	.....	28 32	32 50	4 18	396
402	" "	10.45	2.57	.....	7.56	2.33	2.46	12.35	.....	9.89	.....	2.95	.....	28 06	......	......	402
	Average	12.63	2.73	2.45	7.81	2.16	2.06	12.03	12 50	9.97	10.00	2.34	2.50	28 00	33 75	5 75	
298	Common Sense Fertilizer No. 2	12.69	1.90	.....	.....	3.04	2.08	5.22	.....	3.04	.....	4.44	.....	15 75	35 00	19 25	298
317	" " " "	9.04	1.83	.....	1.39	1.92	1.99	5.30	.....	3.31	.....	4.38	.....	15 97	35 00	19 03	317
362	" " " "	12.46	1.80	.....	.....	3.15	2.30	5.45	.....	3.15	.....	4.62	.....	15 88	35 00	19 12	362
	Average	11.40	1.87	3.50	.46	2.70	2.13	5.33	5.00	3.17	.....	4.47	4.00	15 87	35 00	19 13	
316	Common Sense Fertilizer Diamond D	1.70	1.40	.....	.34	1.61	.84	2.79	.....	2.15	.....	2.53	.....	10 36	20 00	9 64	316
363	" " " " "	8.78	1.48	.....	.....	2.68	2.72	5.40	.....	2.68	.....	4.43	.....	14 22	20 00	5 78	363
	Average	5.24	1.44	2.00	.17	2.15	1.78	4.10	3.00	2.42	.....	3.48	2.00	12 29	20 00	7 71	
288	Cumberland Bone Superphosphate	12.15	2.67	.....	5.90	3.35	4.77	14.02	.....	9 25	.....	2.85	.....	28 57	34 00	5 43	288
306	" " "	11.40	2.34	.....	7.56	3.22	3.43	14.21	.....	10.78	.....	2.46	.....	28 78	36 00	7 22	306
322	" " "	11.88	2.74	.....	6.12	4.13	3.70	13.95	.....	10.25	.....	2.97	.....	30 07	35 00	4 93	322
	Average	11.81	2.59	2.50	6.53	3.57	3.97	14.06	12.00	10.10	11.00	2.76	2.50	29 14	35 00	5 86	

FERTILIZERS.

Station Number	Brand.	Manufacturer.	Sampled at	Station Number
287	Cumberland Seeding Down Fertilizer	Cumberland Bone Company, Portland, Me	Bangor	287
305	" "	" " "	Portland	305
323	" "	" " "	Fairfield	323
321	Dirigo Fertilizer	Sagadahoc Fertilizer Co., Bowdoinham, Me	Fairfield	321
337	"	" " "	Unity	337
341	"	" " "	Bowdoinham	341
401	E. F. Coe's High Grd. Amm. Bone Sup'rp'sphate,	E. Frank Coe, New York, N. Y	Skowhegan	401
292	Farrar's Superphosphate	F. S. Farrar & Co., Bangor, Maine	Bangor	292

FERTILIZER ANALYSES.

Station Number	Brand.	Moisture.	Nitrogen Found.	Nitrogen Guaranteed.	Phosphoric Acid Soluble.	Reverted.	Insoluble.	Total Found.	Total Guaranteed.	Available Found.	Available Guaranteed.	Potash Found.	Potash Guaranteed.	Station valuation of one ton.	Selling price.	Selling price exceeds valuation.	Station Number
287	Cumberland Seeding Down Fertilizer	11.05	1.26	.....	2.19	5.00	17.73	24.92	.....	7.19	.....	.87	.....	$26 59	$28 00	$1 41	287
305	" "	11.45	1.85	.....	3.39	5.38	12.47	21.24	.....	8.77	.....	.32	.....	27 32	28 00	68	305
323	" "	12.69	1.66	.....	2.92	4.36	13.01	20.29	.....	7.28	.....	.26	. ..	24 71	27 67	2.29	
	Average	11.73	1.59	1.65	2.84	4.92	14 41	22.15	19.00	7.75	7.00	.49	1.00	26 21	27 67	1 46	
321	Dirigo Fertilizer	6.91	1.65	.....	.26	3.35	9.80	13.41	.....	3.61	....	2.32	.....	18 80	27 00	6 26	321
337	"	11.31	2.62	.....	.....	4.57	10.49	15.06	.....	4.57	.....	2.62	.....	24 00	28 00	4 00	337
341	"	11.59	2.57	.....	.....	4.74	9.75	14.49	.....	4.74	.....	2.96	....	23 96	......	......	341
	Average	9.94	2.28	2.00	.08	4.22	10.02	14.32	10.00	4.31	4.00	2.63	2.00	22 25	27 50	4 59	
401	E. F. Coe's High Grade Amm. Bone Super..	8.13	2.93	2.25	6.99	2.23	2.54	11.76	12.00	9.22	10.50	3.08	3.50	28 51	36 00	7 49	401
292	Farrar's Superphosphate..................	8.11	2.84	3 50	4.59	5.14	1.65	11.38	12.00	9.73	10.50	2.84	3.50	27 82	36 00	8 18	292

FERTILIZERS.

Station Number	Brand.	Manufacturer.	Sampled at	Station Number
366	Flamingo Guano	Flamingo Guano Co., Baltimore, Md	Saco	366
329	" "	" " " " "	Belfast	329
296	Liebeg's Amm. Superphosphate	Flamingo Guano Co., Baltimore, Md	Augusta	296
367	" " "	" " " " "	Saco	367
330	" " "	" " " " "	Saco	330
397	Mayo Superphosphate	Atlantic Fertilizer Co., Boston, Mass	Hallowell	397
303	Original Coe's Superphosphate	Bradley Fertilizer Co., Boston, Mass	Portland	303

FERTILIZER ANALYSES.

Station Number	Brand.	Moisture	Nitrogen.		Phosphoric Acid.							Potash.		Station valuation of one ton.	Selling price.	Selling price exceeds valuation	Station Number
			Found.	Guaranteed.	Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Found.	Guaranteed.				
366	Flamingo Guano	10.94	.52	....	....	5.68	13.62	19.30	....	5.68	....	.25	....	$18 61	$35 00	$16 39	366
329	" "	12.51	.31	....	....	3.66	13.75	17.41	....	3.66	....	.22	....	14 94	35 00	20 06	329
	Average	11.73	.42	.80	....	4.67	13.69	18.35	....	4.67	12.00	.24	.50	16 78	35 00	18 23	
296	Liebeg's Amm. Superphosphate	21.45	1.81	....	1.68	7.19	2.75	11.62	....	8.87	....	.96	....	22 03	...	..	296
367	" " "	23.22	1.55	....	1.14	7.26	2.35	10.75	....	8.40	....	1.23	....	20 37	35 00	14 63	367
330	" " "	16.10	1.93	....	1.90	6.44	5.04	13.38	....	8.34	....	.84	....	22 91	35 00	12 09	330
	Average	20.26	1.77	1.75	1.58	6.96	3.38	11.92	....	8.54	9.00	1.01	1.25	21 77	35 00	13 23	
397	Mayo Superphosphate	13.87	2.51	2.75	8.16	1.05	.87	10.08	12.00	9.21	11.00	3.98	3.50	26 87	36 00	9 13	397
303	Original Coe's Superphosphate	13.25	2.58	2.50	8.26	1.51	2.68	12.45	11.50	9.77	9.00	1.21	....	26 61	33 00	6 39	303

FERTILIZERS.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
308	Potato, Hop and Tobacco Phosphate	Crocker Fertilizer Chemical Co., Buffalo, N. Y	Portland	308
310	Potato Phosphate	Williams & Clark Company, New York, N. Y	Portland	310
343	Quinnipiac Potato Manure	Quinnipiac Fertilizer Company, New London, Conn.	Richmond	343
374	" "	" " " "	Biddeford	374
377	" "	" " " "	"	377
344	Quinnipiac Phosphate	" " " "	Richmond	344
358	" "	" " " "	Saco	358
376	" "	" " " "	Biddeford	376
345	Quinnipiac Grass Fertilizer	" " " "	Richmond	345

FERTILIZER ANALYSES.

Station Number	Brand.	Moisture.	Nitrogen Found.	Nitrogen Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed	Available. Found.	Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Station valuation of one ton.	Selling price.	Selling price exceeds valuation.	Station Number
308	Potato, Hop and Tobacco Phosphate	12.35	2.36	2.47	8.53	1.70	1.05	11.28	11.50	10.23	10.00	4.27	3.78	$28 24	$36 00	$ 7 76	308
310	Potato Phosphate	12.83	2.74	3.71	6.40	.68	.92	8.00	8.50	7.08	7.00	5.95	9.00	27 31	38 00	10 69	310
343	Quinnipiac Potato Manure	8.27	4.12	.....	3.88	2.23	2 53	8.64	.....	6.11	.....	6.73	.....	31 00	37 00	6 00	343
374	" "	9.05	3.67	.....	3.44	3.14	2.28	8.86	.....	6.58	.....	6.26	.....	30 49	37 00	6 51	374
377	" "	7.95	4.08	.....	3.66	2.79	2.37	8.82	.....	6.45	.....	6.64	.....	31 81	37 00	5 19	377
	Average	8.41	3.96	3.70	3.66	2.72	2.40	8.78	8.00	6.38	6.00	6.55	7.00	31 10	37 00	5 90	
344	Quinnipiac Phosphate	15.03	3.11	.....	9.31	.70	.70	10.71	.....	10.01	.....	2.95	....	29 08	37 00	7 92	344
358	" "	14.23	3.24	.....	9.25	1.03	.63	10.89	.....	10.28	.....	2.67	.....	29 81	38 00	8 19	358
376	" "	14.30	2.91	.....	9.01	1.35	.69	11.03	.....	10.36	.....	2.69	.....	28 66	37 00	8 34	376
	Average	13.19	3.09	3.10	9.19	1.03	.67	10.88	12.50	10.22	10.50	2.77	2.50	29 19	37 34	8 15	
345	Quinnipiac Grass Fertilizer	11 05	3.85	3.70	4.78	4.74	1.38	10.90	8.00	9.52	6.00	6.76	6.00	33 89	40 00	6 11	345

FERTILIZERS.

Station Number	Brand.	Manufacturer.	Sampled at	Station Number
339	Sagadahoc Superphosphate	Sagadahoc Fertilizer Co., Bowdoinham, Maine	Pittsfield	339
340	" "	" " " " "	Bowdoinham	340
299	Soluble Pacific Guano	Glidden & Curtis, Boston, Mass	Augusta	299
304	" " "	" " " "	Portland	304
375	" " "	" " " "	Biddeford	375
289	Standard Fertilizer	Standard Fertilizer Co., Boston, Mass	Bangor	289
327	" "	" " " "	Belfast	327
384	" "	" " " "	Gorham	384
328	Standard Guano	Standard Fertilizer Co., Boston, Mass	Belfast	328

FERTILIZER ANALYSES.

Station Number	Brand.	Moisture.	Nitrogen Found.	Nitrogen Guaranteed.	Phosphoric Acid. Soluble.	Reverted.	Insoluble.	Total. Found.	Total. Guaranteed.	Available. Found.	Available. Guaranteed.	Potash. Found	Potash. Guaranteed.	Station valuation of one ton.	Selling price.	Selling price exceeds valuation.	Station Number
339	Sagadahoc Superphosphate	17.27	2.96	.....	5.12	3.23	2.54	10.89	.....	8.35	.....	2.37	.....	$26 46	$31 00	4 54	339
340	" "	11.75	2.86	.....	4.94	3.70	2.59	11.23	.....	8.64	.....	2.51	.....	26 71	......	......	340
	Average	14.51	2.91	2.75	5.03	3.47	2.57	11.06	11.00	8.50	9.50	2.44	2.50	26 58	31 00	4 42	
299	Soluble Pacific Guano	12.12	2.62	....	6.06	2.77	2.80	11.63	.....	8.83	....	2.63	....	26 40	35 00	8 60	299
304	" " "	14.47	2.80	.....	5.98	3.11	2.56	11.65	....	9.09	.....	2.82	.....	27 38	36 00	8 62	304
375	" " "	10.82	2.62	.....	5.92	3.06	2.91	11.89	.....	8.98	....	2.69	.....	26 73	37 00	10 27	375
	Average	12.47	2.68	2.62	5.99	2.98	2.77	11.73	13.25	8.97	10.25	2.72	2.75	26 84	36 00	9 16	
289	Standard Fertilizer	13.19	2.20	.....	7.52	1.58	1.76	10.86	.....	9.10	.....	1.90	.....	24 39	......	......	289
327	" "	11.27	2.29	.....	7.69	1.35	1.46	10.49	.....	9.04	....	2.68	.....	24 98	35 00	10 02	327
384	" "	11.81	2.06	.....	5.88	3.06	3.38	12.32	.....	8.94	.....	2.48	.....	25 01	36 00	10 99	384
	Average	12.09	2.19	.....	7.03	1.99	2.20	11.23	.....	9.03	.....	2.36	.....	24 80	35 50	10 70	
328	Standard Guano	11.62	1.28	.....	7.18	1.12	1.62	9.92	.....	8.30	.....	2.76	.....	20 69	31 00	10 31	328

FERTILIZERS.

Station Number	Brand.	Manufacturer.	Sampled at	Station Number
290	Standard Superphosphate	Standard Fertilizer Company, Boston, Mass	Bangor	290
295	" "	" " " "	Augusta	295
315	" "	" " " "	Auburn	315
333	Stockbridge's Corn and Grain Manure	Bowker Fertilizer Company, Boston, Mass	Unity	333
364	" " "	" " "	Saco	364
371	" " "	" " "	Biddeford	371
335	Stockbridge's Top Grass Dressing	" " "	Unity	335
370	" "	" " "	Biddeford	370
381	" "	" " "	Wells	381

FERTILIZER ANALYSES.

Station Number	Brand.	Moisture.	Nitrogen. Found.	Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Phosphoric Acid. Available. Found.	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Station valuation of one ton.	Selling price.	Selling price exceeds valuation.	Station number
290	Standard Superphosphate	14 37	2.66	....	7.86	1.83	1.96	11.65	. ..	9.69	.....	2.47	. ...	$27 38	......	.....	290
295	" "	15.97	2.64	.....	7 02	2.43	2.47	11.92	.....	9.45	.....	2.38	.....	27 00	$36 00	$9 00	295
315	" "	13.00	3.07	.....	7.47	1.63	2.42	11.52	.....	9.10	.....	2.81	....	28 39	38 00	9 61	315
	Average	14.45	2.79	3.00	7.45	1.97	2.29	11.71	13.50	9.42	11.00	2.56	3.00	27 59	37 00	9 41	
333	Stockbridge Corn and Grain Manure	9 70	2.99	..	7.56	3.11	1.68	12.35	.....	10.67	....	2.92	.....	30 25	40 00	9 75	333
364	" " "	10.06	3.37	....	6.91	2.40	1.45	10.76	.....	9.31	....	5.70	..	31 70	40 00	8 30	364
371	" " "	4.48	3.46	.....	7.92	2 59	.97	11.48	.....	10.51	.....	4.55	.....	32 63	40 00	7 37	371
	Average	8.08	3.28	3.70	7.47	2.70	1.37	11.53	9.00	10.17	7.50	4.39	4.50	31 53	40 00	8 48	
335	Stockbridge's Grass Top Dressing	9.15	6.25	....	3.96	1.76	3.06	8.78	.....	5.72	.....	3.64	.....	34 07	......	......	335
370	" " "	15.29	5.22	. .	6.56	.83	.52	7.91	....	7.39	.....	2.23	...	31 72	40 00	8 28	370
	Average	12.22	5.73	6.10	5.26	1.30	1.79	8.35	6.50	6.56	5.50	2.93	3.00	32 80	40 00	7 20	

FERTILIZERS.

Station Number	Brand.	Manufacturer.	Sampled at	Station Number
334	Stockbridge's Potato and Vegetable Manure...	Bowker Fertilizer Co., Boston, Mass.................	Unity	334
365	" " " "	" " "	Saco..................	365
369	" " " "	" " "	Biddeford.............	369
382	Stockbridge's Seeding Down Fertilizer.........	Bowker Fertilizer Co., Boston, Mass.................	No. Berwick..........	382
314	Unicorn Amm. Superphosphate...............	Clark's Cove Guano Co., New Bedford, Mass...........	Portland..............	314
338	" " "	" " " "	Burnham	338

FERTILIZER ANALYSES.

Station Number	Brand.	Moisture.	Nitrogen. Found.	Nitrogen. Guaranteed.	Phosphoric Acid. Soluble.	Phosphoric Acid. Reverted.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total. Found.	Phosphoric Acid. Total. Guaranteed.	Phosphoric Acid. Available. Found	Phosphoric Acid. Available. Guaranteed.	Potash. Found.	Potash. Guaranteed.	Station valuation of one ton.	Selling price.	Selling price exceeds valuation.	Station Number
334	Stockbridge's Potato and Vegetable Manure	9.01	4.37	.....	5.20	2.16	1 24	8 60	....	7.36	.....	8.72	.....	$34 52	$40 00	5 48	334
365	" " " "	10.56	3.22	.....	7.07	2.00	1.53	10.60	.....	9 07	.....	5.04	.....	30 40	40 00	9 60	365
369	" " " "	8.86	3.60	. ...	6.35	3.06	2.40	11.81	.....	9.41	.....	4.72	.....	32 30	40 00	7 70	369
	Average	9.48	3.73	4.10	6.21	2.41	1.73	10.34	9.00	8.62	7.50	6.16	5.50	32 41	40 00	7 59	
382	Stockbridge's Seeding Down Fertilizer	10.18	3.09	2.70	7.61	.86	3.32	11.78	11.00	8.47	9.00	2.19	4.50	27 63	40 00	12 37	382
314	Unicorn Amm. Superphosphate	9.23	2.15	.....	5.12	3.63	3.45	12.20	....	8.75	....	3.03	.....	25 44	32 00	6 56	314
338	" " "	10.74	2.12	.....	5.48	3.00	3.94	12.43	....	8.48	.....	2.97	.....	24 90	34 00	9 10	338
	Average	9.98	2.14	2.15	5.30	3.31	3.70	12.31	.....	8.61	9.25	3.00	2.62	25 17	33 00	7 83	

AVERAGES OF ANALYSES.

Brand.	Water.	Nitrogen.	Phosphoric Acid.					Potash.	Station valuation.	Selling price exceeds valuation.	Excess of selling price in percentage of valuation.	No. of samples analyzed.
			Soluble.	Reverted.	Insoluble.	Total.	Available.					
Allen Fertilizer	7.55	2.35	6.20	1.54	1.69	9.52	7.74	5.75	$26 14	$8 86	33.9	1
Americus Amm. Bone Superphos	11.04	2.74	9.69	1.00	.48	11.17	10.69	3.12	29 83	7 85	26.3	3
Ammoniated Bone Superphos	11.88	3.25	7.50	1 90	1.70	11.09	9.39	1.69	27 99	7 68	27.4	3
Bay State Fertilizer	10.93	2.68	7.97	2.06	2.79	12.32	10 03	2.69	28 69	7 31	25.4	2
Bay State Superphosphate	17.26	2.85	6.88	1.02	3.09	10.99	7.90	2.40	25 83	9 17	35.5	1
B. D Sea Fowl Guano	12.85	2.57	8.48	1.82	2.01	12.30	10.29	2.07	27 67	6 33	22.9	3
Bowker's Amm Dissolved Bone	12.71	2.53	7.60	2.57	1.88	12.04	10.16	1.84	26 98	7 70	28.5	3
Bowker's Hill and Drill Phosphate	12.05	2.95	7.47	2.52	2.01	11.99	9.99	1.77	28 09	9 24	32.9	3
Bradley's Potato Manure	12.12	2.71	7.39	1.10	1.23	9.71	8.48	6.43	28 69	5 31	18.5	3
Bradley's Eureka Fertilizer	6.49	2.12	3.26	4.01	4.83	12.10	7.27	3.36	23 96	4 04	16.8	3
Bradley's X. L. Superphos	14.16	2.79	8.20	1.92	1.81	11.92	10.12	2.15	28 07	7 27	25.8	3
Cleveland Superphos	12.63	2.73	7.81	2.16	2.06	12.03	9.97	2.34	28 00	5 75	20.5	3
Common Sense Fertilizer No. 2	11.40	1.87	.46	2.71	2.13	5.33	3.17	4.47	15 87	19 13	120.5	3
Common Sense Fertilizer, Diamond D	5.24	1.44	.34	2.15	1.78	4.10	2.42	3.48	12 29	7 71	62.7	2
Cumberland Bone Superphos	11.81	2.59	6.53	3.57	3.97	14.06	10.10	2.76	29 14	5 86	20.1	3
Cumberland Seeding Down Fertilizer,	11.73	1.59	2.84	4.92	14.41	22.15	5.75	.49	26 21	1 46	5.5	3
Dirigo Fertilizer	9.94	2.28	.08	4.22	10.02	14.32	4.31	2.63	22 25	4 59	20.0	3
E. F. Coe's High Grade Amm. Bone Superphosphate	8.13	2.93	6.99	2.23	2.54	11.76	9.22	3.08	28 51	7 49	26.2	1
Farrar's Superphosphate	8.11	2.84	4.59	5.14	1.65	11.38	9.73	2.84	27 82	8 18	29.4	1
Flamingo Guano	11.73	.42	....	4.67	13 69	18.35	4.67	.24	16 78	18 23	108.6	2
Liebig's Amm Bone Superphos	20.26	1.77	1.58	6.96	3.38	11.92	8.54	1.01	21 77	13 23	60.77	3
Mayo Superphosphate	13 87	2.51	8.16	1.05	.87	10.08	9.21	3.98	26 87	9 13	33.9	1
Original Coe's Superphosphate	13.25	2.58	8.26	1.51	2.68	12.45	9.77	1.21	26 61	6 39	24.1	1
Potato, Hop and Tobacco Phosphate	12.35	2.36	8.53	1.70	1.05	11.28	10.23	4.27	28 34	7 76	27.9	1
Potato Phosphate	12.83	2.74	6.40	.68	.92	8.00	7.08	5.95	27 31	10 69	39.14	1

Quinnipiac Potato Manure...........	8.41	3.96	3.66	2.72	2.40	8.78	6.38	6.55	31 10	5 90	18.9	3
Quinnipiac Phosphate...............	13.19	3.09	9.19	1.03	.67	10.88	10.22	2.77	29 19	8 15	27.9	3
Quinnipiac Grass Fertilizer...........	11.05	3.85	4.78	4.74	1.38	10.90	9.52	6.76	33 89	6 11	18.1	1
Sagadahoc Superphosphate	14.51	2.91	5.03	3.47	2.57	11.06	8.50	2.44	26 58	4 42	16.6	2
Soluble Pacific Guano...............	12.47	2.68	5.99	2.98	2.77	11.73	8.97	2.72	26 84	9 16	34.1	3
Standard Fertilizer	12.09	2.19	7.03	1.99	2.20	11.23	9.03	2.36	24 80	10 70	43.14	3
Standard Guano	11 62	1.28	7.18	1.12	1.62	9.92	8.30	2.76	20 69	10 31	49.82	1
Standard Superphos.	14.45	2.79	7.45	1.97	2.29	11.71	9.42	2.56	27 59	9 41	34.1	3
Stockbridge's Corn and Grain Manure,	8.08	3.28	7.47	2.70	1.37	11.53	10.17	4.39	31 53	8 48	26.8	3
Stockbridge's Grass Top Dressing....	12.22	5 73	5.26	1 30	1.79	8.35	6.56	2.93	32 80	7 20	21.9	2
Stockbridge's Potato and Veg. Manure,	9.48	3.73	6 21	2.41	1.73	10.34	8.62	6.16	32 44	7 59	23.4	3
Stockbridge's Seeding Down Fertilizer,	10.18	3 09	7.61	.86	3.32	11.78	8.47	2.19	27 63	12 37	44.77	1
Unicorn Amm. Superphosphate........	9.98	2.14	5.30	3.31	3.70	12.31	8.61	3.00	25 17	7 83	31.1	2

MISCELLANEOUS FERTILIZERS.

Below are given the analyses of three samples of bone, and one of sulphate of potash.

Station Number	Brand.	Manufacturer.	Sampled at
361	Allen's Pure Ground Bone	American Man. Co. Boston, Mass.	Saco.
297	Ground Bone	E. J. Philbrook, Augusta	Augusta.
312	Pure Guano Bone.......	C. W. Belknap & Son, Portland..	Portland.
379	Bradley's Sulphate Pot'sh	Sold by Bradley Fert. Co., Boston, Mass.	Kennebunk.

Brand.	Moisture.	Nitrogen.	Phosphoric Acid.	Selling Price.	Station Number.
Allen's Pure Ground Bone.....	6.24	4.06	20.99	$35 00	361
Ground Bone................	9.66	4.14	21.34		297
Pure Guano Bone............	7.09	3.17	23.46		312
	Moisture.	Potash,	Selling Price.		Stat'n No.
Bradley's Sulphate Potash.....	1.41	24.35		$50 00	379

ANALYSES OF MUCK.

During the year 1887 several samples of muck were sent to the station from different parts of the State, and these have been analyzed with a view to determining their absorbent and fertilizing value.

These samples were as follows:

No. of Sample—278. From William Downs, So. Sebec.
" " 279. " L. H. Blossom, Turner.
" " 280. " S. L. Holbrook, Brunswick.
" " 281. " A. C. Chandler, New Gloucester.
" " 282. " D. B. Johnson, Freedom.

The tables below show the pounds of organic matter and mineral matter in 100 lbs. of the dry substance of the muck, the composition of the mineral part, and the nitrogen and mineral substances in 100 lbs. water-free muck.

	278	279	280	281	282
Water in fresh muck	83.24	75.05			
Water in air dry muck	51.60	41.90	41.12	23.35	24.80
Ash in air dry muck	6.32	12.27	2.22	32.25	26.61
Organic matter in 100 lbs. water free muck	86.94	78.88	96.19	57.93	65.39
Mineral matter in 100 lbs. water free muck	13.06	21.12	3.81	42.07	34.61
	100.00	100.00	100.00	100.00	100.00
COMPOSITION OF MINERAL MATTER.					
Insoluble part, sand silica, &c	2.85	81.33	57.88	84.50	68.61
Iron oxide and alumina	2.72	-	7.80	8.39	7.35
Lime	50.16	3.42	6.51	4.46	10.59
Magnesia	2.37	-	4.10	.37	.37
Potash	.17	.33	4.50	.10	.80
Soda	2.35	-	4.45	.33	.10
Sulphuric acid (S O3)	5.38	.82	2.69	.81	2.38
Phosphoric acid (P2 O5)	1.27	5.46	7.01	.61	5.69
Carbonic acid, coal, &c	32.73	-	5.06	.43	4.11
	100.00		100.00	100.00	100.00

	278	279	280	281	282	Stable Manure.
Nitrogen of organic matter in 100 lbs. water free muck..	2.77	1.29	1.98	1.15	1.51	1.75
Mineral matter in 100 lbs water free muck, containing:						
Sand, silica, &c......... ..	.37	17.17	2.20	35.53	23.74	36.70
Iron oxide and alumina.....	.35	–	.30	3.53	2.54	2.44
Lime	6.55	.72	.25	1.88	3.67	1.75
Magnesia	.31	–	.15	.15	.12	1.05
Potash	.02	.07	.17	.04	.27	1.40
Soda......................	.30	–	.17	.14	,03	.35
Sulphuric acid............	.70	.17	.10	.34	.82	.35
Phosphoric acid............	.17	1.15	.27	.26	1.97	1.75
Carbonic acid, coal, &c......	4.29	–	.20	.20	1.45	1.06
Total...............	13.06		3.81	42.07	34.61	46.85

The above figures show what the five samples of muck would contain if entirely free from water. It is never the case that muck is entirely dry. It is very retentive of moisture, and even when shoveled out of the pit and allowed to lie in a heap until the dry season—August, for instance—it would then probably contain as much as 50 per cent. of water. When first shoveled out of the bed, 100 lbs. of muck contain 75 or 80 pounds of moisture, sometimes more.

Now, if these mucks were at their best, and held but 50 per cent of moisture, 100 lbs. would contain only half the quantities of nitrogen and mineral ingredients given above, or, if fresh and holding 80 per cent of water, only one-fifth these quantities. The figures given for stable manure are also based on water-free substance, and as this makes up about one-fourth the weight of the manure, 100 lbs. would have one-fourth the pounds mentioned.

It is important to notice the great differences in the several samples of muck.

First, there is a great variation in the amount of organic (vegetable) matter, sample 280 having over one-third more than sample 281. As it is upon the organic matter that the absorbent power of the muck depends, sample 280 is evidently greatly superior for use on the tie-up floor, or under swine.

Again, the several mucks differ in the quantities of manurial ingredients which they contain. Sample 278 has over twice the nitrogen found in samples 279 and 281, while samples 279 and 282 are especially rich in phosphoric acid. Compared with stable manure the average for nitrogen is nearly the same, but the mucks are inferior in the quantities of mineral compounds. It should not be forgotten that the ingredients of the stable manure are much more available than those of the mucks. Until the muck is composted we may believe that it will furnish but little food to a growing plant. If, however, by treatment with lime, or under the influence the fermentation of the manure pile the nitrogen it contains is largely rendered available, the muck bed may be made a not insignificant source of plant food. The whole matter of its use turns upon the cost of getting it to the barn, and from the barn to the field, as compared with what is saved by its use as an absorbent, plus the value of the small amount of plant food which it contains. The latter factor would not average over $2 per ton in the case of the five samples analyzed, reckoning the nitrogen, phosphoric acid and potash at such prices as these ingredients would cost in coarse bone, raw South Carolina rock and muriate of potash, and it is doubtful if these ingredients are as valuable in the muck as in the materials named. This, at least, is plainly taught by these analyses—that each muck bed must be judged upon its own merits. There is muck and muck.

EXPERIMENTS WITH FERTILIZERS.

Prof. Walter Balentine.

Many of the problems connected with manuring have been definitely settled for years. We teach in our agricultural schools that phosphoric acid, potash, magnesia, etc., are essential to plant life with the same assurance that the simple facts of geography are taught in our common schools. We believe as implicitly that the atmosphere is the chief source of carbon to the plant as we do that the earth revolves on its axis.

The chief problems in plant nutrition to-day are not what plants need for their nourishment, but how to supply that nourishment in the cheapest and most effective manner.

The present method of treating rock phosphates to make its phosphoric acid available quadruples the cost of the phosphoric acid to the consumer.

The field for investigation in the direction of reducing this cost, by the means of less expensive methods of preparation, is a promising one.

The successful experiments in the use of the "Thomas Slag" as a source of phosphoric acid certainly gives encouragement to work in this direction. That some plants can obtain nourishment from sources that are not available to other plants seems to be well established.

Investigations as to what plants are especially well adapted for extracting phosphoric acid and potash from their most insoluble compounds should be prosecuted vigorously.

It does not seem improbable that facts might be brought to light from such investigations that would be of great use in devising systems of crop rotation in which ground phosphatic rock and feldspar might be made the chief source of phosphoric acid and potash. The researches of Dr. Atwater on the atmosphere as a source of nitrogen to plants were followed by results which warrant a further investigation of the subject. If there is any class of plants which will gather any considerable quantity of nitrogen from the atmosphere during their growth, they should be made to contribute to the supply of nitrogenous manures.

The number of lines of investigation in feeding plants which may possibly lead to valuable practical results is great, but the most important are those which have for their object cheaper fertilizers for the farmers.

Box Experiments with Fertilizers.

The station has commenced experiments which we hope will aid in solving some of the problems concerning fertilizers, alluded to above.

In 1887, boxes three feet square and one foot high, without bottoms, were procured and set in the earth in the open field. In the spring of 1888 three boxes were filled with loam that had been piled up in a heap and shoveled over many times in order to make it as uniform as possible. One set of these boxes was left without the application of fertilizing material of any kind. The remaining boxes each received an application of 37.5 grammes of muriate of potash, and 50 grammes of sulphate of ammonia. This amount was added that there should be no deficiency in potash or nitrogen to interfere with the success of the experiment. To one set of three boxes which had received the above application of muriate of potash and sulphate of ammonia, 37.5 gr. of dissolved bone black was added to each box. To another set of three boxes there was added to each box 41.1 gr. of finely ground South Carolina rock. To another set of three boxes was added 31.2 grs. of finely ground Aruba phosphate. To another set, 42 grams of finely ground Caribbean Sea guano. To another set 30.7 gr. of powdered Canadian apatite. To another set 33.5 gr. of finely ground Vivorella phosphate, and a set of two was left without the addition of any phosphatic material.

The dissolved bone black was applied at the rate of about 400 lbs. to the acre and carried 16 per cent of soluble phosphoric acid. The application of crude phosphatic material was arranged so that the total phosphoric acid in the crude phosphate should be double the amount of soluble phosphoric acid in the dissolved bone black. The fertilizing material was evenly mixed with four inches of the surface soil, and then, in each box, 260 oat kernels were planted. The boxes were watered with rain water whenever they needed it. Below is given a table showing the analyses of the phosphatic materials used in the experiment, and another table showing the results of the experiment.

Name of Phosphate.	Total Phosphoric Acid	Insoluble Phosphoric Acid.	Available Phosphoric Acid.
Dissolved bone black................	-	-	16.00 per cent.
South Carolina rock, fine ground....	28.64 per cent.	24.17 per cent.	4.47 "
Aruba, fine ground................	35.51 "	32.86 "	2.65 "
Caribbean Sea guano, fine ground ...	28.58 "	20.98 "	7.60 "
Apatite, fine ground..............	39.12 "	38.51 "	0.71 "
Vivorella, fine ground	35.88 "	26.34 "	9.54 "

Fertilizers.	Number of box.	Yield of grain in grams.	Yield of straw in grams.	Average yield of grain per box in grams.	Average yield of straw per box in grams.	Average yield of grain and straw per box in grams	Av. yield of boxes in excess of the average of the boxes to which muriate of potash and sulphate of ammonia alone was applied—grams.
Nothing	1 2 3	163.1 154.9 159.3	234 203 260	159.1	232.3	391.4	16.0
Dissolved bone black, 37.5 gr Muriate of potash, 37.5 gr Sulphate of ammonia, 50 gr	4 5 6	304.6 242.6 180.0	500 409 300	242.4	403.0	645.4	270.0
South Carolina rock, 41.1 gr., Muriate of potash, 37.5 gr Sulphate of ammonia, 50 gr	7 8 9	219.1 196.1 213.7	302 350 289	209.6	313 7	523.3	197.9
Aruba, 31.2 gr Muriate of potash, 37.5 gr Sulphate of ammonia, 50 gr	10 11 12	257.8 152.8 199.7	389 339 250	203.4	326.0	529.4	204.0
Caribbean Sea guano, 42 gr Muriate of potash, 37.5 gr Sulphate of ammonia, 50 gr	13 14 15	176.7 382.2 * 70.2	352 400 377	209.7	376.3	586.0	210.6
Canadian apatite, 30.7 gr Muriate of potash, 37.5 gr Sulphate of ammonia, 50 gr	18 19 20	129.5 137.1 151.5	239 289 279	139.4	269.0	408.4	33.0
Vivorella, 33.5 gr Muriate of potash, 37.5 gr Sulphate of ammonia, 50 gr	21 22 23	250.1 212.6 152.6	385 350 287	205.1	340.7	545.8	170.4
Muriate of potash, 37.5 gr Sulphate of ammonia, 50 gr	25 26	142.9 171.8	229 207	157.4	218.0	375.4	

*The low yield of grain obtained from box 15 probably results from a loss of grain from shelling.

This experiment leaves little room to doubt but all of the crude phosphates, except the apatite, caused a large increase in the crop. In the case of the Vivorella there was an increase of 45 per cent. over the boxes which were fertilized with muriate of potash and sulphate of ammonia alone. With the Caribbean Sea guano the increase amounted to 59 per cent. The aruba gave an increase of 54 per cent, and the South Carolina rock 52 per cent.

These experiments in boxes will be continued, and to them will be added pot experiments, in which the only source of phosphoric acid will be the crude phosphates.

FIELD EXPERIMENTS WITH FERTILIZERS.

In 1886 the station instituted a series of field experiments with the object of gaining information on the following points, viz.:

(1) The comparative value of phosphoric acid in its various forms available for use.

(2) The use of a partial as compared with a complete fertilizer.

(3) The relative profits resulting from the use of different quantities of fertilizers.

(4) The comparative results from the use of stable manure and commercial fertilizers.

The field selected for these experiments is a clayey loam adapted to grass and grain. Previous to 1885 it had been three years in grass, having been well manured with ashes and stable manure when seeded down. In 1885 a crop of barley was taken off without the addition of fertilizers of any kind.

The field was divided into thirty-six plots, arranged in two tiers of eighteen plots each. The plots extended east and west, and were eight rods long by one rod wide. The plots were separated by a strip of land eight feet wide, in which was a ditch deep enough to remove all surface water.

To diminish the errors due to inequalities in the field, three plots in different portions of the field receive the same treatment. In 1886 the land was sown to oats. In 1887 oats were sown again, and the ground seeded to grass, and in 1888 a crop of hay was taken off.

During the years 1886 and 1887 the field received fertilizers in the proportions indicated in the following tables. There was no application of manure of any kind in 1888.

The tables below give the average yield in grain and hay of three plots receiving the same treatment.

For further information see Station Report, 1886-7.

METHODS OF MANURING.

TABLE I.

Kind of Fertilizor.	Quantity of Fertilizer per Acre.	Av'age yield of Grain per plot, 1886.	Av'age yield of Grain per plot, 1887.	Average yield of Hay per plot, 1888.
Nothing	–	83.5 lbs.	40. lbs.	128.3 lbs.
Dissolved bone black Muriate of potash Sulphate of ammonia	400 lbs. 100 " 200 "	12.43 "	58. "	121.7 "
Fine ground bone Muriate of potash Sulphate of ammonia	360 " 100 " 140 "	11.43 "	47.8 "	140.0 "
Fine ground S. C. rock Muriate of potash Sulphate of ammonia	300 " 100 " 200 "	108.3 "	53.2 "	128.3 "
Muriate of potash Sulphate of ammonia	100 " 200 "	96.8 "	52.6 "	116.7 "
Stable manure	40,000 lbs	110.8 "	57. "	205. "

TABLE II.

Kind of Fertilizor.	Quantity of Fertilizer per Acre.	Av'age yield of Grain per plot, 1886.	Av'age yield of Grain per plot, 1887.	Average yield of Hay per plot, 1888.
Nothing	–	78.7 "	42.3 "	81.7 "
Dissolved bone black	400 lbs.	82.8 "	42.1 "	108.3 "
Dissolved bone black Muriate of potash	400 " 100 "	81.5 "	36.6 "	103.3 "
Dissolved bone black Muriate of potash Sulphate of ammonia	200 " 50 " 60 "	86.3 "	45. "	108.3 "
Dissolved bone black Muriate of potash Sulphate of ammonia	300 " 100 " 120 "	103.5 "	42.9 "	88.3 "
Dissolved bone black Muriate of potash Sulphate of ammonia	400 " 150 " 180 "	102. "	60.7 "	118.7 "

It will be noticed from the results of these experiments given in Table I., dissolved bone black, with potash and ammonia salts, give the highest yield of grain, fine ground bone standing next, while fine ground South Carolina rock and stable manure produce about the same results. In 1888, without the further addition of manure, the stable manure stands far ahead of the others in its yield of hay, while the fine ground bone stands next.

In the experiment with partial and complete fertilizers, the results of which are given in Table II., those plots which were fertilized with the complete fertilizer gave the largest yield in grain; and while the heaviest application does not seem to be necessary to produce the maximum yield of grain the first year, the heaviest application is felt in increased yield in the hay crop.

From some unaccountable reason the medium application of the complete fertilizer fails to increase the yield of the grain the second year, and the yield of hay the third year is correspondingly low.

Field Experiments with Fertilizers by Farmers.

In the spring of 1886, the Station sent to farmers located in different parts of the State experimental sets of fertilizers, which were to be used according to certain directions given by the Station, the results of the experiments to be reported to the Station.

The objects in view in coöperating with farmers in this sort of experimental work were the following:

(1.) To stimulate habits of inquiry and observation.

(2.) To render farmers more familiar with the composition of fertilizers.

(3.) To add something, if possible, to our stock of knowledge in regard to the profitable use of commercial fertilizers.

It was hoped to secure these results not only through the observations and experience of the farmers conducting the experiments, but also through the interest that the experiments might excite among other farmers in the localities to which the experimental sets of fertilizers were sent.

Fourteen farmers undertook experiments. With six of these the work resulted in utter failure, in most cases due to a drouth, which either prevented the proper germination of the seed or so dwarfed the crop from lack of water as to prevent any beneficial effect the fertilizers might otherwise have had.

Eight carried their experiments through successfully, and the results were reported in the Station Report for 1886-87.

In 1887 experimental sets were again sent out to various farmers, ten of whom have reported their results to the Station.

These reports are presented in the following tables.

Directions for Field Experiments with Fertilizers.

1. Select land that is as uniform in character as possible, and which has received no manure for several years (run-out land if you have it).

2. The required dimensions of the whole piece are 8x11$\frac{1}{8}$ rods, or 132x183 feet.

3. Before the plots are laid out, plow the whole piece, and pulverize thoroughly.

4. Make the size of each plot one-twentieth of an acre, and the dimensions one rod wide and eight rods long.

5. Measure off the plots, and drive a stake at each corner, leaving a strip of land two feet wide between the plots. If the land is inclined, the length of the plots should be up and down the slope.

6. Number the plots 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10.

7. Put *no* fertilizer on plots 1 and 6, and no fertilizer on any plot except that contained in the bags.

8. Put the fertilizers on the plot numbered to correspond to the numbers on the bag. Put Bag No. 2 on Plot No. 2, etc., etc.

9. Apply the fertilizers in the manner which you have practiced, only be careful that no fertilizer comes in contact with the seed.

10. Make the same number of rows on each plot, with the same number of hills in each row. This can be easily done by cross marking.

11. Put the same amount of the same kind of seed on each plot.

12. Plant the seed (or sow) on the same day on all the plots.

13. Cultivate the plots while the crop is growing, as nearly at the same time as possible.

14. Weigh the crop carefully on each plot, both grain and straw if grain is sown, both corn and fodder if corn is planted, that is, find weight of grain and straw separately.

15. Carefully report any misfortune to the crop on any plot, and keep a record of the appearance of each plot.

It is gratifying to be able to state that the experimenters were painstaking in their efforts to follow the above directions, and that where the experiments escaped unavoidable misfortunes the results were satisfactory, in some cases highly so.

The sets of fertilizers were alike in all respects. Each set consisted of eight bags, containing the materials stated below.

Bag 2.	Dissolved bone black,	20 lbs.
Bag 3.	Dissolved bone black, Muriate of potash,	20 lbs. 5 "
Bag 4. *	Dissolved bone black, Muriate of potash, Sulphate of ammonia,	20 lbs. 5 " 5 "
Bag 5.	Fine ground bone,	20 lbs.
Bag 7.	Same as Bag 2.	
Bag 8.	Same as Bag 3.	
Bag 9.	Same as Bag 4.	
Bag 10.	Same as Bag 5.	

Experiment of S. L. HOLBROOK, Brunswick. Soil, sandy, exhausted, had not been plowed for forty years. Crop, potatoes.

Plot.	Fertilizer Applied.	Amount of Fertilizer per acre.	Yield per plot. Large, pounds.	Small, pounds.	Total, pounds.	Yield per acre. Large, bushel.	Small, bushel.	Total, bushel.
1	No fertilizer	-	26.0	48.0	74.0	8.6	16.0	24.6
2	Dissolved bone black	400	71.0	35.0	106.0	23.6	11.6	35.2
3	Dissolved bone black Muriate of potash	400 100	67.0	5.5	18.5	23.3	17.1	39.5
4	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	105.0	54.0	159.0	35.0	18.0	53.0
5	Fine ground bone	400	37.0	35.	72.0	12.3	11.6	24.0
6	No fertilizer	–	23.0	41.8	64.8	7.6	13.9	21.6
7	Dissoved bone black	400	60.0	37.0	97.0	20.0	12.3	31.3
8	Dissolved bone black Muriate of potash	400 100	61.0	46.0	107.0	20.3	15.3	35.6
9	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	109.0	59.0	168.0	36.3	19.6	56.0
10	Fine ground bono	400	41.0	38.0	79.0	13.6	12.6	26.2
11	Superphosphate	400	159.0	71.0	23.0	53.	23.6	76 6

The cost per acre of these fertilizers is given for the benefit of those who wish to study the results of the following experiments from a financial point of view. These figures include only the cost of the materials delivered in Orono, the small expense of mixing and the freight paid for re-shipping to the various experimenters not being taken into account. The prices which the Station paid for these materials are lower than the retail prices quoted for small lots, but are applicable to lots of several tons.

Bag 2	$6.50	per acre.
Bag 3	9.00	"
Bag 4	13.00	"
Bag 5	7.60	"

*Complete fertilizer.

AVERAGE.

		Yield per Plot			Yield per acre.		
		Large, pounds.	Small, pounds.	Total pounds.	Large, bushels.	Small, bushels.	Total, bushels.
No fertilizer		24.5	44.8	69.3	8.2	14.5	23.1
Dissolved bone black, containing phosphoric acid		65.5	36.0	101.5	21.8	11.9	33.8
Dissolved bone black, Muriate of potash.	Containing phosphoric acid and potash.	64.0	48.5	112.5	21.8	16.2	27.6
Dissolved bone black, Muriate of potash, Sulphate of ammonia.	Containing phosphoric acid, potash and nitrogen.	107.0	56.5	163.5	35.6	18.8	54.4
Fine ground bone....	Containing phosphoric acid and nitrogen.	98.0	36.5	75 5	12.9	12.1	25.0

Experiment of H. L. Leland and W. E. Leland, East Sangerville. Soil, medium clay, slate, loam; had been exhausted by cropping for many years without manuring. Previous hay crop, one-half ton per acre. Crop, potatoes. Season unfavorable.

Plot.	Fertilizer Applied.	Amount of fertilizer per acre.	Total yield per plot.	Total yield per acre.
		lbs.	lbs.	bush.
1	No fertilizer	....	195	65.0
2	Dissolved bone black	400	193	64.3
3	Dissolved bone black Muriate of potash	400 100	191	63.6
4	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	262	87.3
5	Fine ground bone	400	190	63.3
6	No fertilizer	....	125	41.6
7	Dissolved bone black	400	155	51.6
8	Dissolved bone black Muriate of potash	400 100	222	74.0
9	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	285	95.0
10	Fine ground bone	400	116	38.6

AVERAGE.

	Total yield per plot.	Total yield per acre.
	lbs.	bush.
No fertilizer	160	53.3
Dissolved bone black, containing phosphoric acid	174	57.9
Dissolved bone black, Muriate of potash, — Containing phosphoric acid and potash.	206	68.8
Dissolved bone black, Muriate of potash, Sulphate of ammonia, — Containing phosphoric acid, potash and nitrogen.	273	91.1
Fine ground bone, containing phosphoric acid and nitrogen	153	50.9

Experiment of J. F. Purrington, West Bowdoin. Soil, moist, sandy loam, badly run out. Crop, potatoes. Season unfavorable.

Plot.	Fertilizer Applied.	Amount of fertilizer per acre.	Yield per plot.			Yield per acre.		
			Large.	Small.	Total.	Large.	Small.	Total.
		lbs.	lbs	lbs	lbs.	bu.	bu	bu.
1	No fertilizer	......	3.3	21.5	24.8	1.0	7.1	8.1
2	Dissolved bone black	400	20.0	24.3	44.3	6.6	8.1	14.7
3	Dissolved bone black Muriate of potash	400 100	27.0	32.0	59.0	9.0	10.6	19.6
4	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	74.3	33.5	107.8	24.7	11.1	35.8
5	Fine ground bone	400	33.0	20.0	53.0	11.0	6.6	17.6
6	No fertilizer	......	35.0	16.3	19.8	1.1	5.4	6.5
7	Dissolved bone black	400	53.0	30.0	83.0	17.6	10.0	27.6
8	Dissolved bone black Muriate of potash	400 100	73.0	26.5	99.5	24.3	8.8	33.1
9	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	194.0	24.0	21.8	64.6	8.0	72.6
10	Fine ground bone	400	45.0	30.5	75.5	15.0	10.1	25.1

		Yield per plot.			Yield per acre.		
		Large	Small.	Total.	Large.	Small.	Total.
		lbs.	lbs.	lbs.	bu.	bu	bu.
No fertilizer		3.3	18.8	22.0	1.5	6.2	7.7
Dissolved bone black, containing phosphoric acid		36.5	27.1	63.6	12.1	9.0	21.1
Dissolved bone black, Muriate of potash,	Containing phosphoric acid and potash,	50.0	29.2	79.2	16.6	9.7	26.3
Dissolved bono black, Muriate of potash, Sulphate of ammonia,	Containing phosphoric acid potash and nitrogen,	134.1	28.7	162.8	44.6	9.5	54.1
Fine ground bone. .	Containing phosphoric acid and nitrogen,	39.0	25.2	64.2	13.0	8.3	21.3

D. B. Johnson, Freedom.

Crop, *beans.* The experimental field has been in grass for six years. Soil very uniform.

Plot.	Fertilizer Applied.	Amount of Fertilizer per acre.	Yield per acre.		Yield per acre.	
			Beans.	Vines.	Beans.	Vines.
		lbs.	lbs.	lbs.	bush.	lbs.
1	No fertilizer	....	27.3	24.8	9.1	495
2	Dissolved bone black	400	32.5	31.5	10.8	630
3	Dissolved bone black Muriate of Potash	400 100	24.3	19.8	8.0	395
4	Dissolved bone black Muriate of Potash Sulphale of ammonia	400 100 100	35.5	38.3	11.8	765
5	Fine Ground bone	400	31.0	31.0	10.3	620
6	No fertilizer	....	28.0	23.8	9.3	475
7	Dissolved bone black	400	34.5	33.8	11.5	675
8	Dissolved bone black Muriate of potash	400 100	32.0	31.3	10.6	625
9	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	40.0	38.8	13.3	775
10	Fine ground bone	400	28.3	32.5	9.4	650

AVERAGE.

Fertilizer Applied.		Yield per Plot.		Yield per Acre.	
		Beans.	Vines.	Beans.	Vines.
		lbs.	lbs.	bush.	lbs.
No fertilizer		27.6	24	9.14	485
Dissolved bone black, containing phosphoric acid		33.5	33	11.1	652
Dissolved bone black, Muriate of potash,	Containing phosphoric acid and potash,	28.1	26	9.3	510
Dissolved bone black, Muriate of potash, Sulphate of ammonia,	Containing phosphoric acid potash and nitrogen,	37.7	38	12.5	770
Fine ground bone		29.6	32	9.8	635

Experiment of WILLIAM DOWNS, So. Sebec.

Crop, *beans*. Land had had no manure for six years. Soil uniform.

Plot.	Fertilizer Applied.	Amount of Fertilizer per acre.	Yield per plot.	Yield per acre.
			Beans.	Beans.
		lbs.	lbs.	bush.
1	No fertilizer	....	50.0	16.6
2	Dissolved bone black	400	60.0	20.0
3	Dissolved bone black, Muriate of potash	400 100	71.5	23.8
4	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	84.0	28.0
5	Fine ground bone	400	43.0	14.3
6	No fertilizer	....	37.	12.3
7	Dissolved bone black	400	42.5	14.1
8	Dissolved bone black Muriate of potash	400 100	55.5	18.5
9	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	74.5	24.8
10	Fine ground bone	400	46.0	15.3

AVERAGE.

Fertilizer Applied.		Yield per plot. Beans.	Yield per acre. Beans.
		lbs.	bush.
No fertilizer		43.5	14.4
Dissolved bone black, containing phosphoric acid		51.2	17.0
Dissolved bone black, Muriate of potash,	Containing phosphoric acid, and potash,	63.5	21.1
Dissolved bone black, Muriate of potash, Sulphate of ammonia,	Containing phosphoric acid, potash and nitrogen,	79.3	26.4
Fine ground bone		44.5	14.8

Experiment of W. H. Keith, Winthrop. Soil, sandy loam, clay subsoil. The field had not been plowed for nine years. Crop, barley. The grain only was weighed.

Plot.	Fertilizers Applied.	Amount of fertilizer per acre.	Yield per plot—grain.	Yield per acre—grain.
		lbs.	lbs.	bush.
1	No fertilizer	....	29	12.0
2	Dissolved bone black	400	25	10.4
3	Dissolved bone black Muriate of potash	400 100	33	13.7
4	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	47	19.5
5	Fine ground bone	400	30	12.5
6	No fertilizer	....	20	8.2
7	Dissolved bone black	400	24	10.0
8	Dissolved bone black Muriate of potash	400 100	36	15.0
9	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	44	18.3
10	Fine ground bone	400	30	12.5

AVERAGE.

	Yield per plot—grain.	Yield per acre—grain.
	lbs.	bush.
No fertilizer	24.5	10.1
Dissolved bone black, containing phosphoric acid	24.5	10.2
Dissolved bone black, Muriate of potash, — Containing phosphoric acid and potash.	34.5	14.3
Dissolved bone black, Muriate of potash, Sulphate of ammonia, — Containing phosphoric acid, potash and nitrogen.	45.5	18.9
Fine ground bone, containing phosphoric acid and nitrogen	30.0	12.5

Experiment of J. A. TOLMAN, Rockland.

Soil gravelly loam, had been cropped for ten years without manure.

Crop, *barley*, sown for fodder.

Plot.	Fertilizer Applied.	Amount of Fertilizer per acre.	Yield per plot.	Yield per acre.
		lbs.	lbs.	lbs.
1	No fertilizer	....	136	2720
2	Dissolved bone black	400	99	1980
3	Dissolved bone black Muriate of potash	400 100	81	1620
4	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	129	2580
5	Fine ground bone	400	110	2200
6	No fertilizer	....	90	1800
7	Dissolved bone black	400	116	2320
8	Dissolved bone black Muriate of potash	400 100	108	2160
9	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	114	2280
10	Fine ground bone	400	86	1720

AVERAGE.

	Yield per plot.	Yield per acre.
	lbs.	lbs.
No fertilizer	113.	2260
Dissolved bone black, containing phosphoric acid	107.5	2150
Dissolved bone black, Muriate of potash, — Containing phosphoric acid and potash,	94.5	1890
Dissolved bone black, Muriate of potash, Sulphate of ammonia, — Containing phosphoric acid, potash and nitrogen,	121.5	2430
Fine ground bone, containing phosphoric acid and nitrogen	98.	1960

Experiment of G. M. Douglass, Cornish. Soil sandy and run out. Crop, corn.

Plot.	Fertilizer Applied.	Amount of fertilizer per acre.	Yield per Plot.			Yield per Acre.		
			Grain.	Fodder.	Total.	Grain.	Fodder.	Total.
		lbs.	lbs	lbs.	lbs	bush.	lbs.	lbs.
1	No fertilizer	......	103.5	116.0	219.5	27.6	2320	4390
2	Dissolved bone black	400	106.0	119.5	225.5	28.3	2390	4510
3	Dissolved bone black Muriate of potash	400 100	84.0	145.8	229.8	22.4	3915	4595
4	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	151.0	201.0	352.0	40.3	4020	7080
5	Fine ground bone	400	106.0	116.0	222.0	28.3	2320	4440
6	No fertilizer	......	103.5	108.0	211.0	27.6	2160	4220
7	Dissolved bone black	400	102.0	140.0	242.0	27.2	2800	4840
8	Dissolved bone black Muriate of potash	400 100	93.5	144.5	238.0	25.0	2890	4760
9	Dissolved bone black Muriate ol potash Sulphate of ammonia	400 100 100	135.5	186.0	321.0	36.1	3720	6420
10	Fine ground bone	400	94.5	110.8	205.3	25.0	2214	4108

AVERAGE.

		Yield per Plot.			Yield per Acre.		
		Grain.	Fodder.	Total.	Grain.	Fodder.	Total.
		lbs.	lbs.	lbs.	bu.	lbs.	lbs.
No fertilizer		113.5	114.0	215.0	27.6	2243.0	4305
Dissolved bone black, containing phos. acid		104.0	128.5	233.7	28.0	2595.0	4675
Dissolved bone black, Muriate of potash.	Containing phos. acid and potash.	88.5	145.3	233.8	24.0	2902.5	4677
Dissolved bone black, Muriate of potash, Sulphate of ammonia,	Containing phosphoric acid, potash and nitrogen.	143.5	193.5	336.5	38.4	3870.0	6750
Fine ground bone....	Containing phos. acid and nitrogen.	100.5	113.3	213.6	27.0	2267.5	4272

Experiment of A. L. MOORE. Soil, gravelly loam, very poor from long cropping. Crop, corn.

Plot.	Fertilizer Applied.	Amount of Fertilizer per acre.	Yield per Plot.			Yield per acre.		
			Grain.	Fodder.	Total.	Grain.	Fodder.	Total.
		lbs.	lbs	lbs.	lbs.	bush.	lbs.	lbs.
1	No fertilizer	......	120	100	220	32	2000	4400
2	Dissolved bone black	400	108	112	220	28	2240	4400
3	Dissolved bone black Muriate of potash	400 100	128	140	268	34.1	2800	5360
4	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	172	272	444	45.9	5440	8880
5	Fine ground bone	400	96	100	196	20.6	2000	3920
6	No fertilizer	......	84	100	184	22.4	2000	3680
7	Dissolved bone black	400	100	100	200	26.7	2000	4000
8	Dissolved bone black Muriate of potash	400 100	100	140	240	26.7	2800	4800
9	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	152	240	392	20.5	4800	7840
10	Fine ground bone	400	128	240	368	34.1	4800	7360

AVERAGE.

		Yield per Plot.			Yield per acre.		
		Grain.	Fodder.	Total.	Grain.	Fodder.	Total.
		lbs.	lbs.	lbs.	bu.	lbs	lbs.
No fertilizer		102	100	202	27.2	2000	4040
Dissolved bone black, containing phosphoric acid		104	106	210	27.0	2100	4200
Dissolved bone black, Muriate of potash,	Containing phosphoric acid and potash,	114	140	254	30.0	2800	5080
Dissolved bone black, Muriate of potash, Sulphate of ammonia,	Containing phosphoric acid, potash and nitrogen,	162	256	418	33.0	5120	8360
Fine ground bone,	Containing phosphoric acid and nitrogen,	112	170	282	27.0	3400	5640

Experiment of J. E. Shaw, Hampden. Soil, gravel loam. Had been cropped eight years. Cut about 500 lbs of hay in 1886. Crop, corn.

Plot.	Fertilizers Applied.	Amount of fertilizer per acre.	Yield per Plot.			Yield per Acre.		
			Grain.	Fodder.	Total.	Grain.	Fodder.	Total.
		lbs.	lbs.	lbs.	lbs.	bush.	lbs.	lbs.
1	No fertilizer	......	87	125	206	21.6	2500	4120
2	Dissolved bone black	400	68	104	172	17.3	2080	3440
3	Dissolved bone black Muriate of potash	400 100	108	172	280	28.3	3440	5600
4	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	126	200	326	33.6	4000	6520
5	Fine ground bone	400	80	136	216	21.3	2720	4320
6	No fertilizer	......	–	75	75	–	1500	1500
7	Dissolved bone black	400	15	95	110	4.0	1900	2200
8	Dissolved bone black Muriate of potash	400 100	77	175	252	44.5	3500	5040
9	Dissolved bone black Muriate of potash Sulphate of ammonia	400 100 100	100	225	325	26.5	4500	6500
10	Fine ground bone	400	106	215	321	28.3	4300	6420

AVERAGE.

	Yield per Plot.			Yield per Acre.		
	Grain.	Fodder.	Total.	Grain.	Fodder.	Total.
	lbs.	lbs.	lbs.	bu.	lbs.	lbs.
No fertilizer.	40.5	100.0	140.5	10.5	2000	2810
Dissolved bone black, containing phosphoric acid,	41.5	99.5	141.0	10.7	1990	2820
Dissolved bone black, Muriate of potash, | Containing phosphoric acid and potash.	92.5	173.5	266.0	34.2	3470	5320
Dissolved bone black, Muriate of potash, Sulphate of ammonia, | Containing phosphoric acid, potash and nitrogen.	113.0	212.5	325.5	30.0	4250	6510
Fine ground bone, containing phos. acid and nit.,	93.0	175.5	268.5	25.0	3570	5370

In these experiments the Complete Fertilizer, or bag No. 4, produced the largest crop. In three experiments none of the fertilizers produced gains large enough to pay for the fertilizers. In seven experiments bag No. 4 caused gains large enough to pay for the fertilizers. In one case, that of the experiment by Mr. Shaw, bag No. 3 was the most profitable fertilizer.

In general, the complete fertilizers are the most profitable. There are a few cases in which partial fertilizers are more economical for the time being.

FOODS.

GENERAL EXPLANATIONS.

The general object of the analyses and experiments which have been undertaken during 1887 and 1888 was to make progress in ascertaining the comparative composition and digestibility of the cattle foods that are available for use by Maine farmers, and to test in a practical manner the efficiency and economy of certain combinations of food ingredients in the production of milk and meat.

The composition of our principal cattle foods of American production is now quite well known, and yet it is very evident that to this, and especially to the digestibility of our fodder plants, more study should be given. If we except timothy and the clovers, only a few analyses have been made of our hay producing plants, while the number of determinations of their digestibility is scarcely worth mentioning. For instance, Dr. Jenkin's tables of American feeding stuffs, which are intended to be a full compilation, show but one analysis of Red Top and one of Orchard Grass, the names of several other valuable upland grasses not appearing. Our knowledge of the feeding value of some of our native grasses seems to be especially meagre. For these reasons it is proposed to do something each year at the Maine Experiment Station in learning more about our hays and coarse fodders, so far as this can be done by analyses and digestion experiments. We have quite generally assumed that our fodders have the same average digestibility as are given in the German tables. It is very probable that this assumption is not correct in all cases. This is explained by the fact that our cattle foods are grown in a climate and with cultivation different from what exist in Europe, and while the laws controlling animal nutrition are the same everywhere, this difference in the character of our food stuffs may render the averages of the analyses and coefficients of digestibility of foreign materials inapplicable to practice in this country. Work was begun in this direction in 1885, and has been kept up more or less continuously until the present time. In 1887, the work was considerably enlarged. In that year all the species of hay-producing plants found on the College Farm that could be obtained in sufficient quantity unmixed were gathered, carefully dried and stored, their composition and digestibility, being subsequently determined.

Again, quite a large variety of cattle foods are found in the markets which are bye products, either from milling or from the manufacture of oils, such as the brans, fine feed, damaged flour, oil meals, etc.

The composition of each of these feeding stuffs is characteristic, and is less subject to large variations than is the case with coarse foods, but is affected somewhat by the processes of manufacture and unfavorable conditions of storage. Samples of quite a variety of such of these materials as are sold in Maine have been collected by the Station, the analyses of which will appear in the near future.

But a knowledge of the composition and digestibility of cattle foods has practical value only to the extent that we can apply it to methods of feeding in such a way as to cheapen production. Such a use of the information gained by laboratory investigations is the object of the practical feeding experiments carried on by the

Station. The aim is to reduce cattle feeding to a system, so that there shall be no waste, or in other words, so that the maximum production shall be obtained from a given weight of food. The basis of such a system must be *a knowledge of the proper combinations of food ingredients*, for the various purposes of stock feeding. When possessed of this knowledge the farmer can then select his supply of purchased foods with reference to his needs, and from the cheapest sources. The following explanations of the nature and office of the ingredients of cattle foods are offered as an aid to understanding the analytical and experimental data given farther on.

*Explanations.** The analysis of any plant or animal substance with reference to its use as a cattle food does not go so far as to determine the percentage of every single ingredient in the material analyzed, but only aims to learn the percentages of certain classes of compounds, the members of each class having a close resemblance in composition and in nutritive effect. Thus we have in all fodder tables several columns of figures headed by the following terms: Water, Ash, Protein, Crude Fiber, Nitrogen-free Extractive Matter, and Fats. As these terms are in constant use, not only in this report but in all agricultural literature, they are made the subject of such explanations as seem necessary in order to show their relation to animal nutrition.

The *water* or *moisture* of cattle foods, of which all contain more or less, is measured by the loss of weight which takes place when the substance is dried for some time at the temperature of boiling water, or 212° Fahrenheit. The percentage of water is very large in green crops, sometimes constituting more than nine-tenths their weight, and comparatively small in all dried materials. In all feeding stuffs which exist in the air-dry condition, the percentage of moisture varies somewhat according to the state of the atmosphere, so that in rainy or moist weather a given quantity of hay or grain that is at all exposed to the air will weigh more than during a time of dryness. Freshly cured hay and newly harvested grain contain more water than old hay and grain, the difference being an important consideration in buying or selling by weight. While the water in cattle foods has no nutritive value above water that an animal drinks, its presence or absence often has a marked influence upon the palatableness of feeding stuffs.

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*These explanations will not appear in future bulletins and reports.

The *ash*, or mineral part of any food stuff, is that which is left after the combustible portion is burned away, and includes quite a number of compounds. The amount of ash in plants is influenced in a marked manner by their age, and conditions of growth, such as locality, soil, kind of manuring. The mineral compounds of cattle foods fill an important place in furnishing entirely the material for building up the bony framework of the animal.

Protein is a collective term that includes quite a variety of compounds. which are distinguished from the members of the other important classes of substances in feeding stuffs by the fact that they contain nitrogen. Protein includes two general classes of compounds, viz., *albuminoids* and *amides*.

Such compounds as egg albumen, the muscular tissue of animals and the caseine of milk are *albuminoids*, and to these animal substances the albuminoids of plants bear a close resemblance both in chemical properties and in food value. The protein of feeding stuffs cannot be directly determined with accuracy. The estimation is an indirect one, and is based upon the fact that all albuminoids contain approximately 16 per cent of nitrogen. If, therefore, the percentage of nitrogen in any feeding stuff be multiplied by 6.25, the percentage of albuminoids is obtained with sufficient accuracy for all practical purposes. The important and peculiar office which albuminoids fill in serving the uses of the animal kingdom is that they constitute the only source of material for the formation of muscular tissue, hair, horn, the caseine of milk, and all other organic nitrogen compounds of the animal body.

Plants contain other nitrogenous compounds called *amides* that occur most abundantly in fodder and root crops, the amount varying at different periods of growth, while in the grains the nitrogen exists almost wholly in the form of albuminoids. Fodder tables generally give as the percentage of protein the product of the total percentage of nitrogen by 6.25.

A given amount of protein, as stated for hay in tables of fodder analyses, is not quite the same thing, therefore, as the same amount occurring in the grains, because in the former case much more of the nitrogen belongs to the non-albuminoid, or amide form.

The true value of amides in animal nutrition is not well defined. That they are wholly like albuminoids in office seems hardly probable, at least previous investigations do not show this.

Crude fiber is the woody part of plants, and is that which remains undissolved after treating vegetable substance with weak acids and alkalies. Paper and cotton fiber are good examples of nearly pure crude fiber.

The *nitrogen-free extractive matter* includes all the non-nitrogenous compounds of feeding stuffs, excepting crude fiber and the fats, the most important and best known members of this class being starch and the sugars.

The *fats* or vegetable oils are extracted from plant substance by ether, which also takes out more or less chlorophyl, wax, etc., especially in the case of hays and coarse fodders. Olive, linseed and cotton-seed oils are good examples of vegetable fats.

The starch, sugar and fats can play no part in the formation of flesh or the caseine of milk, but are alike in being a source of animal fat and heat.

It has been assumed that the digestible portion of crude fiber has a feeding value similar to starch and sugar, but the investigations of the past few years throw a doubt on this assumption. It is also probable that all the compounds included in the term, "nitrogen-free extractive matter," have not equal nutritive value, the starch and sugars being the only substances of which definite statements can be made.

FODDER ANALYSES.

The only fodder analyses that are presented in this are those of samples of grasses and other plants, which were collected on the College Farm in the summer of 1887.

In that year all the species of hay producing plants found on the College Farm that could be obtained unmixed in sufficient quantity for analysis and digestion experiments were gathered, carefully dried and stored. With one exception, samples of all the species analyzed were selected while the plants were in full bloom, the orchard grass being somewhat past bloom when cut. The time of cutting was during the first ten days of July, except in case of the blue joint, which was gathered later.

The composition and digestibility of these grasses were thoroughly studied and the results of this work are presented in as plain and concise a manner as possible.

The first table following shows the composition of the fodders in the air-dry condition as they would be fed, and also what the composition would be if they contained no water. The terms used in the table are explained on the previous pages.

Table of Fodder Analyses.

Station Number.	Description of Samples.	In 100 parts of air-dry substance.						In 100 parts of water-free substance.				
		Water.	Ash.	Protein.	Crude Fiber.	Nitrogen-free extractive matter.	Fats.	Ash.	Protein.	Crude Fiber.	Nitrogen-free extractive matter	Fats.
XLI....	Alsike clover. *Trifolinun hybridum*, 1887. In full bloom................	12.55	7.86	12.69	27.86	35.63	3.41	8.99	14.51	31 86	40.74	3.90
XLII...	White clover. *Trifolinun repens*, 1887. In bloom for some time............	12.39	7.42	15.12	24.91	36.49	3.67	8.47	17.26	28 43	41.65	4.19
XLIII..	Blue joint. *Calamagrostis Canadansis*, 1887. Cut late in July............	8.62	5.46	9.19	33.10	40.81	2 82	5.97	10.06	36.22	44.66	3.09
XL.....	Orchard grass. *Dactylis glomerata*, 1887. Past bloom 7 to 10 days.........	10.95	6.25	7.50	33.02	39.25	3.03	7.02	8.42	37.08	44.08	3.40
L.......	Red top. *Agrostis vulgaris*, 1887. In full bloom........................	11.60	4.47	8.56	27·38	44.78	3.21	5.06	9.69	30.98	50.61	3.63
XLIV ..	Timothy. *Phleum pratcnse*, 1887. In full bloom........................	8.32	4.20	7.50	29.94	46.74	3.30	4.58	8.18	32.66	50.98	3.60
LI......	" " " From large lot of hay somewhat past bloom.	12.60	4.52	6.85	28.05	44.84	3.14	5.17	7.84	32.10	51.30	3.59
XLV....	Wild oat grass. *Danthonica spicata*, 1887. In bloom....................	8.33	3.49	6.87	31.26	47.38	2.67	3.81	7.49	34.10	51.74	2.86
XXXIX	Witch grass. *Triticum repens*, 1887. In bloom.........................	10.85	4.83	8.50	33.94	38.52	3.36	5.41	9.53	38.07	43.21	3.78
XLVI ..	Buttercup. *Ranunculus acris*, 1887. In full bloom......................	10.43	6.01	9.06	30.44	40.71	3.35	6.71	10.11	33.97	45.47	3.74
XLVII .	White weed. *Leucanthemum vulgare*, 1887. In full bloom................	9.63	6.85	8.44	29.00	41.72	4.36	7.58	9.34	32.09	46.17	4.82

The samples from which these analyses were made were grown on the same farm, under quite similar conditions of climate and soil, and so any differences in the composition of the various species of clovers, grasses, etc., would seem to be characteristic, so far as they are not occasioned by cutting at unlike stages of growth. In all but one instance, however, the samples were taken as nearly as possible while the plants were in the period of full bloom.

From the above analyses it is not apparent that wild oat grass, blue joint, buttercup, and white weed have a composition inferior to the more highly prized timothy and red top, in fact the former plants are more nitrogenous than the latter.

The popular impression is different nevertheless, and if farmers are correct in their conclusions we must look farther than the ordinary analysis of a fodder in order to learn its feeding value, for most certainly stock feeders are not willing to allow that blue joint is more valuable than good upland grasses like timothy and red top, as the analyses seem to show. We need more information than is given by the figures of an ordinary table of fodder analyses.

We should remember that in estimating protein by the formula Nx6.25, we learn nothing of the character of the nitrogen compounds in different feeding stuffs, that the nitrogen-free-extractive matter is determined by difference, with no knowledge whether the amounts present of the more valuable carbohydrates like starch and sugar are relatively the same in all, and that the nutrition to be derived from a food depends as much upon its digestibility as upon its composition. It may be that after we learn all that we can on these points we shall come to the conclusion that farmers are very much influenced by the palatableness of a food in forming their opinions of its value, and it may be that some of our feeding stuffs commonly regarded as inferior, simply need to be rendered palatable in order to become efficient cattle foods. We have no evidence showing that fodders are necessarily nutritious in proportion as they are relished by cattle.

In fact the qualities which render a cattle food palatable have no direct connection with its capacity for sustaining animal life.

The composition of the eleven samples mentioned in the above tables of analyses has been studied somewhat more thoroughly than is usual.

Attention was given to two points:

(1) The amount of non-albuminoid material which by the usual method is reckoned as part of the protein.

(2) The composition of the nitrogenous-free extractive matter, so far as it can be learned by a direct determination of the sugars, starch and gums.

THE ALBUMINOID AND AMIDE NITROGEN.

The albuminoid nitrogen was determined in nine of the eleven samples grown in 1887.

	TABLE II.	In 100 parts of Dry Air Substance.			Per cent of total nitrogenous material in albuminoid form.
		Total nitrogen.	Albuminoid nitrogen.	Non-albuminoid nitrogen.	
		%	%	%	%
XLI	Alsike Clover	2.03	1.77	.26	87.2
XLII	White Clover	2.42	2.03	.39	84.6
XLIII	Blue Joint	1.47	1.30	.17	88.4
XL	Orchard Grass	1.20	1.15	.05	95.8
XLIV	Timothy	1.20	1.07	.13	89.2
XLV	Wild Oat Grass	1.10	.99	.11	90.0
XXXIX	Witch Grass	1.36	1.24	.12	91.2
XLVI	Buttercup	1.45	1.37	.08	94.5
XLVII	White Weed	1.35	1.27	.08	94.1

So far as we can judge by these determinations, there were no marked differences in the nitrogenous compounds of these fodders, but it is possible for the protein of one fodder to be essentially unlike that of another, without this being shown by the mere separation of the albuminoid from the non-albuminoid (amide) nitrogen.

The figures show, however, that the protein of these feeding stuffs existed largely in the more valuable, or albuminoid, form.

COMPOSITION OF THE NITROGEN-FREE EXTRACTIVE MATTER.

As before stated, the non-nitrogenous part of fodders, excluding the crude fiber and fats, is made up of quite a variety of compounds. Among these are the sugars and starch, of whose composition and nutritive properties we have definite knowledge. The gums are also included in this class of compounds, and as they, like starch, are inverted to sugar by the action of an acid, it is fair to suppose that they, like starch, are changed to sugar in the process of digestion, and that they have a value in nutrition very similar to starch. Beyond the compounds mentioned, the nitrogen-free extractive matter is, in the case of fodder plants, made up of substances of which we have very little definite knowledge. Enough is known, however, to make it reasonably certain that the carbohydrates (sugar, starch and gums) are the most valuable part of the non-nitrogenous compounds of a hay, the fats excepted, and therefore, that the larger the percentage of the nitrogen-free extractive matter, which exists as carbohydrates, the more valuable the fodder, other things being equal. Consequently, it is reasonably certain that the nitrogen-free extractive matter of the grains has a greater nutritive value than that of the coarse fodders, because in the former case it is made up almost wholly of starch and the sugars.

If it were found then that one species of grass, or grass cut at a particular time, was comparatively rich in starch and sugar, it might safely be considered a point in its favor. With a portion of these fodders an attempt has been made to ascertain the percentages of the more valuable carbohydrate material, viz., that which, after taking out the ordinary percentage of crude fiber, exists as the sugars, and as starch and other compounds that by treatment with an acid are changed to sugar.

The following table contains the percentages of the sugars, and starch in the fodders. The term "starch" is intended to include all material, not sugar, that is inverted by the treatment with an acid.*

*On following pages of this report can be seen the methods employed by Mr. Bartlett in the determination of the sugars and starch. The method used for starch and other material subject to inversion to sugar by an acid seems to have especial merit, as it provides that the production of sugar from crude fiber shall be no more and no less than is the case in crude fiber determinations, and that all other carbohydrate compounds shall be completely inverted.

NITROGEN-FREE EXTRACTIVE MATTER.

		In 100 parts Water-Free Substance.						
		Total nitrogen-free extractive matter.	Sucrose.	Glucose.	Starch.	Total sugars and starch.	Nit-free extractive matter not sugars and starch.	Per cent of total nitrogen-free extractive matter as sugar and starch
		%	%	%	%	%	%	%
XLI	Alsike Clover	40.74	1.49	3.09	10.64	15.22	25.52	37.36
XLII	White Clover	41.65	.39	2.73	15.77	18.89	22.76	45.35
XLIII	Blue Joint	44.66	2.23	3.53	14.49	20.25	24.41	45.34
XL	Orchard Grass	44.08	1.54	4.05	16.53	22.12	21.96	50.18
L	Red Top	50.64	3.14	4.25	16.58	23.95	26.69	47.29
XLIV	Timothy	50.98	3.70	6.76	16.17	26.63	24.35	52.24
LI	Timothy	51.30	3 25	6.48	14.92	24.65	26.65	48.06
XLV	Wild Oat Grass	51.74	1.78	3.76	17.46	23.00	28.74	44.46
XXXIX	Witch Grass	43.21	2.57	5.09	16.66	24.32	18.89	56.29
XLVI	Buttercup	45.47	.60	4.65	9.15	14.40	31.07	31.66
XLVII	White Weed	46.17	.79	4.39	10.77	15.95	30.22	34.54

The above figures show that the true carbohydrates form a much larger part of the nitrogen-free extractive matter of some plants than of others. For instance the white weed has nine-tenths as much non-nitrogenous material as the timothy (No. XLIV), but of sugar the latter has twice as much, and of starch one and a half times as much, as the former. In other words, more of the nitrogen-free extractive matter of the white weed consists of compounds of which we have some reason to suspect a nutritive value inferior to starch and sugar. Just what these compounds are in composition and in nutritive value we do not know. They form in these instances from a fifth to a quarter of the dry substance of the plant, and in general constitute an unknown factor in the compounding of rations involving the use of coarse fodders.

DIGESTION EXPERIMENTS.

GENERAL CONSIDERATIONS.

The composition alone of any feeding stuff is a very imperfect standard by which to judge its food value. Of the food consumed by an animal, only that portion which is digested, *i. e.*, that which is dissolved by the several digestive fluids and passes into the blood, can serve to maintain the vital functions, or to produce growth. Consequently, certain cattle foods, by being much more digestible than others, are much more completely utilized.

The main facts of digestion, and those upon which the methods of digestion experiments are based, are the following: A portion of the food which an animal eats is dissolved by the several digestive fluids with which it comes in contact, viz., the saliva, gastric juice, pancreatic juice, etc. That which is dissolved, or digested, is absorbed by certain vessels which are distributed over the lining of the stomach and intestines, passes into the blood, and is then used to maintain and build up the animal body. The undissolved or undigested portion of the food is carried along the alimentary canal, passes from the body as the feces or dung, and constitutes that part of the food which is useless for the purposes of the nutrition. The method of ascertaining the digestibility of any cattle food is simple in principle. An animal is fed a weighed quantity of food, of which the composition is determined by analysis. The solid excrement is collected, weighed and analyzed, and the amount digested is the difference between that which is fed and that which is excreted. From the data thus obtained is calculated the percentage that is digested of each ingredient, these several percentages being called the *coefficients of digestibility*. As the process of digestion is slow, it is necessary to feed the animal on the weighed ration several days before collecting any excrement, in order that the contents of the intestines may become wholly freed from the residue of the previous food, so that the dung collected shall come wholly from the food tested. On account of the irregularity with which dung is voided, it is collected for several days, and from the total amount the average for one day is calculated.

The digestibility of these fodders was studied through digestion experiments with sheep and by treating them with artificial solutions of pepsin and pancreas.

EXPERIMENTS WITH SHEEP.

In the digestion experiments with sheep the animals used were full grown wethers in all cases. They were confined during the time the experimental rations were fed, in stalls large enough to allow comfortable lying down, but small enough to oblige the animal to feed in such a way as to prevent loss. The feed boxes were zinc lined, and projected up around the head in front and at the sides so that none of the finely cut fodder could easily be scattered out. The feces was collected in rubber lined bags closely attached to the animal by a light leather harness, and any loss of either fodder or dung could be easily detected.

The feeding period with each food was twelve days, during the last five of which the feces was collected, the preliminary feeding of the first seven days being considered necessary to entirely free the digestive apparatus from any residue of former food. Fortunately the rations were completely consumed, except in two instances where the amounts uneaten were too small to materially affect the results. The feces was collected twice each day, weighed on a balance sensitive to one-half grain, and from the whole amount, carefully mixed, one-tenth was taken and dried for analysis.

The data needed for calculating the coefficients of digestibility are:

(1) The composition of the foods eaten.

(2) The composition of the feces.

(3) The weight of food eaten and dung excreted.

The composition of the fodders has already been given. That of the feces follows. The second contains the weights of food consumed, and of solid excrement voided.

COMPOSITION OF FECES.

	From	Water.	Water-free Substance.	In 100 parts Water-free.				
				Ash.	Protein.	Crude Fiber.	Nitrogen-free extractive matter.	Fats.
		%	%	%	%	%	%	%
XLI....	Alsike clover..................	74.76	25.24	11.08	13.70	40.94	27.65	6.63
XLII...	White clover............. ..	58.19	41.81	10.30	13.55	32.84	37.24	6.07
XLIII..	Blue joint....	65.45	34.55	8.97	7.28	38.27	42.22	3.26
XL. ...	Orchard grass.................	65.27	34.73	10.03	7.66	34.54	44.15	3.62
L.......	Red top........................	59.16	40.84	9.01	9.06	28.33	48.81	4.79
XLIV ..	Timothy........................	55.02	44.98	7.75	9.45	35.95	44.79	5.06
LI......	Timothy..........	58.61	41.39	8.10	9.50	33.80	43.55	5.05
XLV ...	Wild oat grass.................	57.72	42.28	7.86	9.55	29.55	48.66	4.38
XXXIX	Witch grass....................	67.29	32.71	8.05	8.54	38.76	40.84	3.81
XLVI ..	Buttercup.....................	64.56	35.44	7.93	9.69	45.53	34.22	2.63
XLVII..	White-weed....	64.57	35.43	8.64	9.24	41.37	36.40	4.35

WEIGHTS EATEN AND EXCRETED.

		*Total fodder consumed in five days		Total feces excreted in five days.	
		Air dry.	Water free substance.	Fresh	Water free substance.
		grams	grams.	grams.	grams.
XLI........	Alsike Clover	3500	3060.7	4624	1166.9
XLII........	White Clover..................	3500	3066.3	2498	1044.5
XLIII........	Blue Joint....................	3500	3198.3	5568	1922.2
XL........	Orchard Grass.................	3500	3116.7	4093	1421.7
L........	Red Top.......................	3500	3094.0	3203	1308.0
XLIV	Timothy.......................	3500	3208.8	2452	1102.9
LI........	†Timothy......................	3000	2622.0	2907	1203.2
XLV	‡Wild Oat Grass...............	2800	2566.8	2448	1034.6
XXXIX	Witch Grass...................	3500	3120.2	3826	1251.4
XLVI	Buttercup	3500	3135.0	3887	1377.6
XLVII.	White Weed	3500	3163.0	3768	1335.1

*Except in cases noted, 700 grams daily.

†Only 600 grams daily.

‡Only four days.

We now have all the figures necessary for calculating the digestibility of the fodders, and this done in table.

CALCULATIONS OF THE DIGESTIBILITY.

Table.	Dry Substance	Organic Matter.	Ash.	Protein.	Crude Fiber	Nitrogen-free extractive matter.	Fats.
XLI—Alsike Clover							
Total fed, 700 grams daily......	612.1	557.	55.1	88.8	195.0	249.4	23.9
" excreted, 924.8 grams daily	233.4	207.5	25.9	32.0	95.5	64.5	15.5
" digested..............	378.7	349.5	29.2	56.8	99 5	184.9	8.4
Per cent digested..............	61.9	62.7	53.	64.	51.	74.1	35.1
XLII—White Clover.							
Total fed, 700 grams daily.......	613.3	561.4	51.9	105.8	174.3	255.4	25.7
" excreted, 499.6 grs. daily.	208.9	187.4	21.5	28.3	68 6	77.9	12.7
" digested................	404.4	374.0	30.4	77.5	105.7	177.5	13.0
Per cent digested................	66.	66.6	58.5	73.2	60.6	69.5	50.6
XLIII—Blue Joint.							
Total fed, 700 grams daily......	639.7	601.5	38 2	64.3	231.7	285.6	19.8
" excreted, 1113 6 grs. daily	384.4	350 0	34.4	28.0	147.1	162.3	12.5
" digested................	255.3	251.5	3.8	36.3	84.6	123.3	7.3
Per cent digested................	39 9	41.8	10.	56.5	36.5	43.2	37.
XL—Orchard Grass.							
Total fed, 700 grams daily......	623.3	579 6	43.7	52.5	230.9	274.8	21.1
" excreted, 818.6 grs. daily	284 3	255.9	28.4	21.8	98.2	125 5	10.3
" digested................	339.0	323.7	15.3	30.7	132 7	149.3	10.8
Per cent digested................	54.4	55 8	35.	58.5	57.5	54.4	51.2

	Dry substance.	Organic matter.	Ash.	Protein.	Crude fiber.	Nitrogen-free extractive matter	Fats.
L—Red Top.							
Total fed, 700 grs. daily	616 8	585.6	31.2	59.8	191.1	312 3	22.4
" excreted, 640.6 grs. daily .	261.6	238 0	23.6	23.7	74.1	127.7	12 5
" digested daily	355.2	347.6	7 6	36.1	111.0	184.6	9 9
Per cent digested...............	57.6	59.3	24.3	60 4	61.2	59 1	44.2
XLIV—Timothy.							
Total fed, 700 grs. daily	641.8	612.4	29 4	52.5	209.6	327.1	23.1
" excreted, 490.4 daily......	220.6	203.5	17.1	20.8	79.3	92 2	11 2
" digested daily	421.2	408 9	12.3	31.7	130.3	234.9	11.9
Per cent digested...............	65.7	66.8	41.8	60.4	62 1	71.8	51 5
LI—Timothy.							
Total fed, 600 grs. daily	524.4	497.3	27.1	41.1	168 3	269.0	18.8
" excreted, 581.4 grs. daily..	240.6	221.1	19.5	22.8	81.3	104.8	12.1
" digested daily............	283.8	276.2	7.6	18.3	87.0	164.2	6.5
Per cent digested..............	54.1	55.5	28.0	44.5	51.7	61.0	34.6
XLV—Wild Oat Grass							
Total fed, 700 grs. daily	641.7	617 2	24 5	48 0	218.8	332 0	18.3
" excreted, 612 grs. daily....	258.6	238.3	20.3	24.7	76.4	125.8	11.3
" digested daily............	383.1	378.9	4.2	23.3	142.4	206 2	7.0
Per cent digested..............	59.6	61.2	17.1	48.6	65.1	62.1	38.2
XXXIX—Witch Grass.							
Total fed, 700 grs. daily........	624.	590.3	33.7	59 5	237.5	269.7	23.6
" excreted, 765.2 grs. daily..	250.3	230.2	20.1	21.3	97.0	102.2	9.5
" digested.................	373.7	360.1	13.6	38 2	140 5	167.5	14.1
Per cent digested...............	59.9	61.	40.3	64.2	67.6	62.1	60.
XLVI—Buttercup							
Total fed, 700 grs. daily........	627.	585.	42.	63.4	213.	285.1	23.5
" excreted, 777.4 grs. daily..	275.5	253 7	21.8	26.7	125.4	94.3	7.2
" digested.................	351.5	331.3	20.2	35.7	87 6	190.8	16.3
Per cent digested...............	56.1	56.6	48.1	56.3	41.1	66.9	69.7
XLVII—White Weed.							
Total fed, 700 grs. daily........	632.6	584.7	47.9	59.1	203.	292.	30.5
" excreted, 753 6 grs. daily..	267.	244.	23.	24.6	110.5	97.2	11.6
" digested.................	365 6	340.7	24.9	34.5	92.5	194.8	18.9
Per cent digested................	57.8	58.3	52.	58.4	45.5	66.7	62.

For the sake of convenience in comparing the digestibility of the different fodders, the coefficients of digestibility are arranged in the following table:

COEFFICIENTS OF DIGESTIBILITY.

		Dry Substance.	Organic Matter.	Ash.	Protein.	Crude Fiber.	Nitrogen-free extractive matter.	Fats.
XLI....	Alsike clover..........	61.9	62.7	53	64.	51.	74.1	35.1
XLII...	White clover............	66.	66.6	58 5	73.2	60.6	69.5	50.6
XLIII..	Blue joint..............	39.9	41.8	10.	56.5	36.5	43.2	37.
XL.....	Orchard grass...........	54.4	55.8	35.	58.5	57.5	54.4	51.2
L.......	Red top..............	57.6	59.3	24.3	60.4	61.2	59.1	44.2
XLIV ..	Timothy	65 7	66.8	41.8	60.4	62·1	71.8	51.5
LI......	Timothy	54.1	55.5	28.	44.5	51.7	61.	34.6
XLV ...	Wild oat grass..........	59 6	61 2	17.1	48 6	65.1	62.1	38.2
XXXIX	Witch grass.	59.9	61.	40.3	64 2	67 6	62 1	60.
XLVI ..	Buttercup.	56.1	56.6	48.1	56.3	41.1	66.9	69.7
XLVII..	White-weed............	57.8	58.3	52.	58.4	45.5	66.7	62.
	PREVIOUS EXPERIMENTS.							
XXIV..	*Alsike clover..........	54.9	56 2	–	55.5	46.2	64 1	53.2
XIV....	†Timothy	–	59.3	–	42.1	52.	65.7	47.6
XXIII..	*Timothy	51.6	52.4	–	45.2	42.8	58.9	55.
XXVII..	*Oat straw	50.3	52.	–	?	57.6	53.2	38.3

*See report of Maine Experiment Station, 1886-7.

†Ibid, 1885-6.

In order to see more closely the differences in the digestible material of the several feeding stuffs we must construct a table, showing the actual pounds of the various ingredients digested out of 100 lbs. of the food. This is done by multiplying the pounds of each ingredient in a hundred pounds of the food by the percentage (or coefficient) of digestibility.

QUANTITIES OF NUTRIENTS DIGESTED.

		From 100 lbs. air-dry food.				
		Total Organic matter.	Protein.	Crude Fiber.	Nitrogen-free extractive matter.	Fats.
XXIV ..	Alsike clover	46.4	5.58	14.03	25.1	1.58
XLI. ..	" "	49.9	8.12	14.2	26.4	1.20
XLII...	White clover	54.8	12.85	13.68	25.97	2.39
XLIII ..	Blue joint	36.3	5.75	12.83	16.54	1.15
XL.	Orchard grass	46.2	3.38	18 98	21.35	1.55
XXVII .	Oat straw	44.9	?	21.85	22.3	1.16
XIV....	Timothy	50.4	2.95	15.9	25.7	1.12
XXIII..	"	44.5	2.68	12.36	27.9	1.47
XLIV ..	"	58.4	4.53	18.6	33.5	1.70
LI......	"	46.	3.05	14.50	27.3	1.08
XLV ...	Wild oat grass	54.	3.33	20.35	29.42	1.55
XXXIX	Witch grass	52.4	5.53	20.28	24.72	1.89
XLVI...	Buttercup	48.5	5.43	12.03	28.29	3.07
XLVII .	White weed	50.4	4.87	14.15	28.57	2.54

7

Digestibility of Nitrogen-Free Extractive Matter.

With a part of these fodders an attempt has been made to ascertain the digestibility of the more valuable carbohydrate material, viz., the sugars, and starch and other compounds that by treatment with an acid are changed to sugar, crude fiber excepted. In order to compare the digestibility of these compounds with that of the total nitrogen-free extractive matter, determinations of the sugars, starch and other non-nitrogenous material capable of inversion to sugar have been made in the feces from several of the fodders, by a method exactly similar to that used for the hays.

The following tables contain the percentages of starch in the feces, and a comparison of the calculated digestibility of the carbohydrates with that of the total nitrogen-free extractive matter. The term starch is intended to include all material, not sugar, that is inverted by the treatment with an acid.

	Feces from	In 100 parts water-free substance.			Percentage of nitrogen-free extractive matter as starch.
		Total nitrogen-free extractive matter.	Starch.	Compounds not starch.	
XLI	Alsike clover	27.65	6.44	21.21	23.29
XLII	White clover	37.24	13.74	23.50	36.89
XLIII	Blue joint	42.22	10 73	31.49	25.41
XL	Orchard grass	44.15	10.50	33.65	23.78
L	Red top	48.81	12.44	36.37	25.49
XLIV	Timothy	41.79	11.38	30.41	27.23
LI	Timothy	43.55	11.67	31.88	26.80
XLV	Wild oat grass	48.66	12.85	35.81	26.41
XXXIX	Witch grass	40.84	11.94	28.90	29.23
XLVI	Buttercup	34.22	5.98	28.24	17.47
XLVII	White weed	36.40	5.64	30.76	15.49

NITROGEN-FREE EXTRACTIVE MATTER.

		Fed in one day.			Excreted in one day.			Digested in one day.			Digested from 100 parts fed of		
		Sugar and starch.	Not sugar and starch.	Total.	Starch.	Not starch.	Total.	Sugar and starch	Not sugar and starch.	Total.	Sugar and starch.	Not sugar and starch.	Total.
XLI	Alsike clover	93.1	156.2	249.3	15.0	49.5	64.5	78.1	106.7	184.8	85.9	68.3	74.1
XLII	White clover	115.8	139.5	255.3	28.7	49.1	77 8	87.1	90.4	177.5	75.2	64 8	69.5
XLIII	Blue joint	129.5	156.1	285.6	41.2	120.9	162.1	88.3	35.2	123.5	68.2	22.5	43.2
XL	Orchard grass	137.9	136.9	274.8	29 8	95.7	125.5	108.1	41 2	149 3	78.4	30.1	54.4
L	Red top	147.7	164.6	312.3	32.5	95.1	127.6	115.2	69 5	184 7	78.0	42 2	59.1
XLIV	Timothy	170.9	156.3	327.2	25.1	67.1	92.2	145.8	89.2	235.0	85.3	57.1	71.8
LI	Timothy	150.8	163 0	313.8	32 7	89 5	122.2	118.1	73.5	191.6	78.4	45.1	61.0
XLV	Wild oat grass	147.6	184.4	332.0	33.2	92.6	125 8	114.4	91.8	206.2	77.5	49.7	62.1
XXXIX	Witch grass	151 8	117.9	269.6	29.9	72.3	102 2	121.9	45.6	167.5	80.6	38.7	62.1
XLVI	Buttercup	90 3	194.8	285.1	16.5	77.8	94 3	73.8	117.0	190.8	81.7	60.0	66.9
XLVII	White weed	100.9	191.2	292.1	15.1	82.1	97.2	85.8	109.1	194.9	85.1	57.1	66.7

The above figures show that sugar, starch, and other compounds that are inverted to sugar by the action of an acid, are found in larger quantity in some fodders than in others, in proportion to the total non-nitrogenous material, and moreover, that these carbohydrates whose value as nutrients is well established constitute the most digestible part of the total nitrogen-free extractive matter. These facts seem to explain in part why the bare statement of the analysis of a fodder as given in fodder tables does not constitute a definite measure of its value.

SUMMARY.

Some of the practical lessons to be drawn from the facts previously presented, are summarized below:

(1) The upland grasses,* so far as analyzed, do not differ greatly in composition.

(2) The different species of upland grasses were found to differ very little from one another, and from Alsike clover, in digestibility. The Blue Joint, in the one experiment made, had a low comparative rate of digestibility.

(3) While the total amount of dry substance digested out of 100 lbs. of the hay from the true grasses, such as Timothy, Witch Grass, etc., and from Alsike clover, was very nearly the same in all cases, the character of the material from the clover differed materially from that digested out of the grasses, being much more nitrogenous, and therefore better adapted than the grasses to the nutrition of an animal forming albuminoids rapidly, such as a milch cow or a young growing animal.

(4) The fodders proved to be quite unlike in the percentages of sugar and starch which they contained, and which was digestible. The cases observed so far are too few to allow general conclusions, but there seems to be good reason for the assertion that the analyses of our fodders would much more fully give a measure of nutritive value if they showed what are the ingredients of the non-nitrogenous portion of the plant. For instance, the White Weed has as much non-nitrogenous material as the Timothy, (XLIV) 31 per cent of this being sugar and starch in one case, and 52 per cent in the other. Any analysis that stops short of showing these facts fails to give data that is important in judging of nutritive value.

*The term grasses is used strictly in a botanical sense. The clover are not true grasses.

WHOLE CORN *vs.* CORN MEAL.

On pages 97 and 98 of the Maine Experiment Station Report for 1886-7, can be seen the results of a feeding experiment with whole corn against corn meal, which shows no difference in the feeding value of the two foods.

This experiment was repeated with somewhat older animals, under very similar conditions.

A lot of western corn was purchased, one-half of which was ground. Six pigs of quite uniform quality and size were selected from the same litter, and at the time the experiment was begun they were about five months old. They were divided into two lots, as equal as possible in size and quality, and were fed eighty-four days. The first period of feeding occupied forty days and the last forty-four. In the first period Lot 3 was fed meal, and Lot 4 whole corn. In the second period this order was reversed, Lot 3 getting the whole corn.

The rations were as follows:

Period 1.

Lot 3.	Lot 4.
12 pounds corn meal. Water.	12 pounds whole corn. Water.

Period 2.

Lot 3.	Lot 4.
18 pounds whole corn. Water.	18 pounds corn meal. Water.

The two lots of pigs gained as shown in the next table.

	Meal—Lot 3.	Whole Corn—Lot 4.
Period 1, weight October 9th	511 pounds.	478 pounds.
weight November 17th	616 "	612 "
Gain in 40 days	105 pounds.	134 pounds.
	Lot 4.	Lot 3.
Period 2, weight November 17th	616 pounds	612 pounds.
weight December 31st	763 "	749 "
Gain in 44 days	147 pounds.	137 pounds.
Total gain with whole corn	281 pounds.	
Total gain with meal	242 "	

The results of the two years' experiments are certainly favorable to feeding whole corn, for it seems to produce as much gain, pound for pound, as meal, and the cost of grinding is at least saved. Does it pay to even shell corn when that raised on the farm is fed?

THE COMPOUNDING OF RATIONS FOR THE DIFFERENT CLASSES OF FARM ANIMALS.

The economical use of cattle foods is a matter to which farmers are very properly giving much attention.

Concerning the most efficient and economical rations for this or that kind of stock, our agricultural papers contain numerous inquiries and answers. In fact, the feeding for milk and meat production is a department of farm practice to which the aid of scientific facts and principles are called to such an extent as to encourage the belief that farmers are beginning in some measure to reap the fruit of scientific investigations made in their behalf.

While there is still a large field for inquiry in the domain of cattle feeding, and many problems yet unsolved, we already possess a mass of organized facts in regard to the composition and digestibility of a large variety of feeding stuffs, the functions of the different nutrients, and the practical effect of certain combinations of foods, that can be made valuable to the intelligent and thoughtful farmer. There are many farmers in the state to whom these facts are not available, or if so, they are distributed through such an amount of literature as to make their possession a laborious task.

It is proposed, therefore, to give in this connection the data and explanations necessary to the calculation of a ration for any specified purpose.

What an efficient and economical ration is, and how to obtain it.

(1) An efficient ration must be sufficient in quantity.

An animal may be very fitly compared to a machine. If we wish to run a machine we must apply force enough to move its various parts, and then if we use it to perform work we must add to this force in proportion to the work done. In the case of the mowing machine, for instance, it requires a certain amount of exertion on the part of the horses to start and keep it in motion, even when no grass is cut, but when the knives are cutting grass the horses must put forth an additional amount of muscular force. So, if an animal is kept alive, gaining nothing and losing nothing, doing no work either as a draft animal or as a producer of milk or meat, yet maintaining an undiminished bodily condition, a certain amount of food will be required to simply run the machine. When the animal is put at some labor, or is used to produce something, then the food must be increased in proportion as the demands upon it are greater.

(2) A ration that is both efficient and economical must not only be sufficient in quantity, but so compounded that there shall be no waste in any direction. It is safe to assert that for a specified purpose, milk production for instance, there is some particular combination of food ingredients that to a greater extent than any other secures a utilization of the food eaten. When a milch cow consumes a ration in which the amount of digestible protein bears such relation to the amount of digestible non-nitrogenous material that each class of nutrients just fills the place to which it is best adapted, we say we have a well balanced ration. If the protein is fed either in a greater or in a less relative quantity, the ration becomes either insufficient or wasteful.

The truth of these statements will be more clearly seen if we consider the matter somewhat in detail.

The food which an animal eats is used for several distinct purposes. These are:

(1) The production of new material, either that in the milk or that stored in the body, the latter including the g owth of the fœtal young.

(2) The supply of the waste caused by muscular activity.

(3) As fuel, which is consumed in keeping up the bodily warmth.

What relation do the various parts of the food sustain to this work? The ingredients of cattle foods, as before enumerated and explained, are, the ash, (mineral matter) protein, (nitrogenous substance) fats or oils, and sugar, starch, gums, &c.

Here we have on the one hand the work to be done, and on the other the means with which to do it. We must first consider whether all the above kinds of material are necessary for running the animal machine, or whether any one of the ingredients named can perform the variety of work that is demanded. In other words, have the ash, albuminoids, fat and starch peculiar parts to play in the animal economy, or can they be used indifferently in any direction where they seem to be most urgently needed?

The investigations of physiologists and chemists have answered this question, and the following may be stated as safe conclusions:

(1) The chief office of the ash of plants is to furnish the bony framework of the animal, besides which it supplies certain mineral compounds that take part in the digestive processes, and that are distributed in small quantities throughout the flesh.

(2) Protein (albuminoids) is the only source of lean meat, hair, horn, hoof or any other nitrogenous substance that becomes incorporated into the animal body. Fat is formed from it, in some instances chiefly perhaps, as in the case of butter fat. It also plays an indispensable, but not fully explained, part in the maintenance of muscular activity, and its decomposition must contribute something to the heat supply of the body. In fact, experience shows that in the absence or deficiency of the other food ingredients, except the mineral compounds, albuminoids can, for a time at least, serve to maintain all those vital processes which otherwise would wholly or in part be supported by the fats and carbohydrates.

(3) The vegetable oils and the carbohydrates are alike in being fat and heat formers. Their combustion is also somehow connected with the maintenance of muscular activity.

In the matter of quantity the fats or oils are relatively unimportant as compared with carbohydrates, and in the case of ordinary cattle foods, the latter class of compounds makes up a very large part of the nutritive substance. The carbohydrates serve to supply the most of the needed fuel, and are important as a source of fat.

We have seen that protein is an indispensable ingredient of cattle foods. Are the fats and carbohydrates? If from the protein can come all the new material, energy and heat needed to nourish and sustain animal life, why be particular about the amount fed, or why take pains to secure a certain relation between the quantities of the different ingredients of the food provided enough is fed? In answering these questions we can appeal partly to physiological facts and partly to experience. One reason why a diet, consisting mostly or entirely of albuminoids, would not be advisable, even if possible, is that the excretory organs would be unnecessarily burdened in throwing off waste products occasioned by the decomposition of the albuminoids, thus causing disease perhaps.

Moreover, experience shows that even a carniverous animal will not continue long in a healthful condition if fed a diet of pure albuminoids, and that the food of herbiverous animals can easily be made so nitrogenous as to create a tendency toward disease.

While the terms "flesh formers," as applied to albuminoids, and "heat formers," as applied to carbohydrates, do not express the whole truth, yet it is a fact that fat, starch, sugar and allied compounds are the natural and economical source of a large part of animal heat, and to some extent of animal fat and muscular power. Science and experience both clearly indicate that these are the peculiar offices of the non-nitrogenous constituents of cattle foods, and that the mixture of food ingredients for which nature has so evidently arranged in the composition of plants, best harmonizes with the laws regulating the maintenance and growth of the animal body. Granting all that goes before, then it is certain, as before stated, that there must be some mixture of food ingredients which secures less waste of material than any other.

Generally speaking we can feel assured that it is rational to feed carbohydrates to the full extent to which they can prevent the use of protein for any purpose to which it is not indispensible. The unnecessary use of protein would in general increase the cost of feeding, with no corresponding returns.

On the other hand, if a ration contains less than the quantity of indispensible protein, production will be limited in proportion to the deficit.

There is, in fact, much less of over-feeding with nitrogenous foods than of under-feeding, although the former mistake may sometimes be made where cotton seed meal is freely used. All these facts force the conclusion that an ill-balanced ration is easily possible, and that there is as good an opportunity to use economy in compounding cattle foods as in buying the materials with which to build a house. It may occur to some to ask whether a farmer, using the ordinary cattle foods at his command, is likely to feed a wasteful or inefficient combination.

For instance, a ration of coarse fodders, roots, corn, meal and bran is not an unusual one, and yet very good evidence can be cited to show that for young animals or milch cows, the same weight of a different mixture would be more economical.

It is well known to every farmer that nothing excels young pasture grass as a food for all classes of stock, milch cows young stock and fattening animals.

This is explained, in part at least, by the fact that such grass is comparatively rich in digestible protein, much richer than the mature plant. But it is the latter which is stored for winter feeding, and this furnishes a much less nitrogenous ration than the grazing animal selects when given the power of choice.

In subjecting our domestic animals to conditions somewhat artificial, placing them as we do entirely at our mercy in the matter of food, the practice has been, especially when we have depended wholly upon the resources of the farm, to feed much less protein proportionally than is supplied by pasture grass, or any other young and succulent material. This is true of even our better class of farmers.

What shall be said then of those who sell their good hay and feed that which comes from inferior low ground grasses, whose cattle eat straw and corn fodder which have been robbed of their protein to produce the grain that is sold?

The writer believes that no mistake in the use of cattle foods has been more general than that of feeding so little digestible protein as to sufficiently meet the requirements for generous growth or milk production.

This defect can be remedied. It is possible, now that the markets offer so great a variety of foods, for those who depend largely upon purchased grain to make good the deficit of home raised materials, to buy that which will balance the ration.

The German Feeding System.

The German feeding standards, as they have come to be called, are an attempt to state in exact terms the quantities of digestible materials of different kinds that the daily rations of the various classes of farm animals should contain in order to secure the best results.

The standards were calculated by Dr. Emil Walff and others from the data furnished by German investigations and experiments, and they represent a large amount of observation and experience. They are in no sense guess-work ; neither should it be said of them that they are wholly theoretical.

It is claimed by some that they should be revised, and it seems probable that not only the actual but the relative amounts for which these standards call will sometime be modified by fuller investigations and larger experience.

So far as we have any hints of what these changes will be, they indicate lower figures for the total digestible material, and a smaller proportion of protein in some cases. Such would certainly be the changes if these standards were made to imitate the practice in vogue among a large percentage of American farmers, for as they now stand they call for very liberal feeding, more liberal, perhaps, than is in all cases profitable. Nevertheless, so long as feeding insufficiently for generous production is a very prevalent fault, it is better, perhaps, that the standards we set should err, if at all, on the side of too generous rather than too small rations.

The quantities stated in these German standards are the amounts of digestible material of different kinds that should be fed daily for each 1000 pounds of live weight. If an animal weighs more or less than one thousand pounds, the ration is to be increased or diminished in proportion.

It is important to notice that not only the amounts, but the kind of digestible material varies with the kind of animal.

This is but a recognition of the obvious fact that the demands upon the food for the various kinds of production are greatly different.

The amounts, and also the proportions, of the several food elements required to maintain a resting animal, or to sustain labor, or to produce rapid growth, or to keep up a liberal flow of milk, are quite unlike.

The differences in total amount of nutrients as shown, are easily seen. In order to express the relation in quantity of the digestible protein to the digestible non-nitrogenous material, there is given in the last column of the following table what is called the *nutritive ratio*.

As an example of how this ratio is calculated, the standard ration for a milch cow is selected. This calls for 2.5 lbs. digestible protein, 12.5 lbs. digestible nitrogen-free extractive matter and fiber, and .40 lbs. digestible fat.

The fat has a greater value per pound than sugar or starch, and in order to reduce the figures to the same basis, we multiply the percentage of fat by $2\frac{1}{2}$, because for heat production a pound of fat is equal to $2\frac{1}{2}$ pounds of the carbohydrates.

$$12.5 + (.40 \times 2\tfrac{1}{2}) = 13.5. \quad 13.5 \div 2.5 = 5.4.$$

The nutritive ratio is therefore 1 : 5.4.

A—POUNDS PER DAY PER 1,000 POUNDS LIVE WEIGHT.

Age—mos.	Kind of Animal.	Total organic matter.	Albuminoids, or Protein.	Nitrogen-free extract and fiber.	Fat	Total nutritive substances.	Nutritive ratio.
	Horse at light work	21.0	1.5	9.5	0.40	11.40	1: 7.0
	" average work	22.5	1.8	11.2	0.60	13 60	1: 7.0
	" hard "	25.5	2 8	13.4	0.80	17 00	1: 5 5
	Oxen at rest in stall	17 5	0.7	8 0	0.15	8.85	1: 12.0
	" ordinary work	24.0	1.6	11.3	0.30	13.20	1: 7.5
	" hard "	26 0	2.4	13.2	0.50	16.10	1: 6.0
	" fattening, first period	27.0	2 5	15.0	0.50	18.00	1: 6.5
	" " second period	26 0	3.0	14.8	0 70	18.50	1: 5.5
	" " third "	25.0	2.7	14.8	0.60	18.10	1: 6 0
	Milk cows	24 0	2.5	12.5	0.40	15.40	1: 5 4
	Sheep, wool-producing (coarser breeds)	20.0	1 2	10 3	0.20	11.70	1: 9 0
	" " " (finer breeds)	22 5	1.5	11.4	0.25	13 15	1: 8.0
	" fattening, first period	26.0	3 0	15.2	0.50	18.70	1: 5.5
	" " second period	25.0	3.5	14.4	0.60	18.50	1: 4.5
	Swine, fattening, first period	36 0	5.9	27.5		32.50	1: 5.5
	" " second period	31.0	4 9	24.0		28.00	1: 6.0
	" " third period	23.5	2.7	17.5		20.20	1: 6.5
	Growing Cattle.						
Age—mos.	Average live weight per head						
2.3	150 pounds	22.0	4.0	13.8	2.0	19.8	1: 4.7
3.6	300 "	23.4	3 2	13.5	1.0	17.7	1: 5.0
6.12	500 "	24 0	2 5	13.5	0.6	16.6	1: 6.0
12.18	700 "	24.0	2.0	13 0	0.4	15.4	1: 7.0
18.24	850 "	24.0	1.6	12 0	0.3	13 9	1: 8.0
	Growing Sheep.						
5.6	56 pounds	28.0	3.2	15.6	0 8	19.6	1: 5.5
6.8	67 "	25.0	2.7	13 3	0.6	16.6	1: 5.5
8.11	75 "	23.0	2.1	11 4	0.5	14.0	1: 6.0
11.15	82 "	22,5	1.7	10.9	0.4	13.0	1: 7 0
15.20	85 "	22.0	1.4	10.4	0.3	12.1	1: 8.0
	Growing Pigs.						
2.3	50 pounds	42 0	7 7	30.0		37 5	1: 4.0
3.5	100 "	34 0	5.5	25.0		30.0	1. 5.0
5.6	125 "	31.5	4.3	23.7		28.4	1: 5.5
6.8	170 "	27.0	3.4	20.4		23.8	1: 6.0
8.12	250 "	21.0	2.5	16.2		18.7	1: 6.5

B—POUNDS PER DAY PER HEAD.

Kind of Animal.	Total organic matter.	Albuminoids or protein.	Nitrogen-free extract and fiber.	Fat.	Total nutritive substance.	Nutritive ratio.
Growing Cattle.						
Age—mos. Av. live weight per head.						
2.3 ....150 pounds,	3.3	0.6	2.1	0.30	3.00	1:4.7
2.6 ....300 "	7.0	1.0	4.1	0.30	5.40	1:5.0
6.12 ....500 "	12.0	1.3	6.8	0.30	8.40	1:6.0
12.18.... ...700 "	16.8	1.4	9.1	0.28	10.78	1:7.0
18.24 ....850 "	20.4	1.4	10.3	0.26	11.96	1:8.0
Growing Sheep.						
5.6 .... 56 pounds,	1.6	0.18	0.87	0.045	1.095	1:5.5
6.8 .... 67 "	1.7	0.17	0.85	0.040	1.060	1:5.5
8.11........ 75 "	1.7	0.16	0.85	0.037	1.047	1:6.0
11.15........ 82 "	1.8	0.14	0.89	0.032	1.062	1:7.0
15.20........ 85 "	1.9	0.12	0.88	0.025	1.047	1:8.0
Growing Pigs.						
2.3 .... 50 pounds,	2.1	0.38	1.50		1.88	1:4.0
3.5 ....100 "	3.4	0.50	2.50		3.00	1:5.0
5.6 ....125 "	3.9	0.54	2.96		3.50	1:5.5
6.8 ....170 "	4.6	0.58	3.47		4.05	1:6.0
8.12.........250 "	5.2	0.62	4.05		4.67	1:6.5

How is a cattle feeder to learn whether his rations compare with the above standards? He must ascertain the composition of his foods and their digestibility; in other words, he must know how much of different ingredients his cattle are eating and what proportion of them is available for use. It is not possible for each farmer to have his feeding stuffs analyzed, but we have tables giving the average composition of a large list of cattle foods as determined by numerous analyses, and the same for the percentages of digestibility, and a calculation made for any given food by means of these averages is perhaps accurate enough for practical purposes.

The Composition of American Feeding Stuffs.

It was but a few years ago that we were obliged to depend upon German analyses for a knowledge of our cattle foods, but so much work has lately been done in this country in the way of investigating agricultural products that we are now well informed in regard to the composition of many American feeding stuffs. Dr. E. H. Jenkins of the Connecticut Experiment Station has published a much needed compilation of American analyses, and here follow his tables as given in the report of the Connecticut Experiment Station for 1887. Under the head of each ingredient can be seen the minimum, maximum and average percentages as found by the several analyses made. For instance, in the case of protein in timothy hay, the left hand column shows that fifty-three analyses have been made, and the column headed *protein* shows that the lowest percentage found was 4.2, the highest 9.6, and the average 6.06.

Name.	Analyses.	Total Dry Matter.			Albuminoids or Protein.			Crude Fat.			Nitrogen-free Extract.			Fiber.			Ash.
		Min.	Max.	Average.	Min.	Max.	Average.	Min.	Max.	Average.	Min.	Max.	Average	Min.	Max.	Average.	
GREEN FODDER.																	
Maize fodder	48	7.1	30.9	19.02	.6	3.0	1.63	.1	.9	.41	3.2	19.7	10.62	1.9	11.4	5.28	1.13
Maize fodder, ensilaged	57	13.0	28.4	19.48	.7	2.8	1.49	.2	1.8	.68	5.1	18.3	10.26	3.0	10.0	5.68	1.31
Sorghum	7	13.6	28.4	21.66	.9	1.4	1.10	.2	.5	.36	5.3	27.0	13.08	4.7	8.5	6.25	.87
Sorghum, ensilaged	5	22.0	28.1	24.17	.6	.9	75	.1	.4	.28	13.8	19.0	15.82	5.9	6.8	6.28	1.04
Rye fodder	6	21.9	25.3	24.72	2.3	3.0	2.61	.2	.7	.56	4.9	12.4	6.94	4.9	14.9	12.73	1.88
Rye fodder, ensilaged	1	-	-	19.25	-	-	2.42	-	-	.27	-	-	9.18	-	-	5.76	1.62
Oat fodder	2	21.4	28.8	25.10	1.5	2.0	1.77	.4	.7	.57	10.8	14.6	12.70	7.1	9.5	8.27	1.79
Clover	1	-	-	26.67	-	-	4.09	-	-	.69	-	-	11.61	-	-	8.12	2.16
Clover, ensilaged	3	21.5	27.4	23.73	3.0	3.8	3.34	.9	1.1	1.02	8.1	11.4	10.21	5.1	8.6	6.66	2.50
Cow-pea vines, green and succulent	2	14.0	17.9	15.93	3.0	3.3	3.12	.6	.6	.60	5.3	8.5	6.90	2.9	4.1	3.48	1.83
Beet leaves	1	-	-	11.16	-	-	2.74	-	-	.60	-	-	2.49	-	-	2.50	2.83
Carrot leaves	1	-	-	16.70	-	-	4.26	-	-	.86	-	-	5.99	-	-	2.25	3.34
Cabbage ensilage	1	-	-	12.39	-	-	1.19	-	-	.93	-	-	4.52	-	-	1.59	4.16
HAY AND DRY COARSE FODDER																	
Clover hay	33	78.2	93.9	88.63	8.9	20.8	12.55	1.5	4.3	2.44	35.0	49.0	40.55	15.6	35.7	26.86	6.23
Hay containing much clover	10	85.5	89.8	86.68	6.3	14.4	10.33	1.5	3.1	2.52	31.8	45.2	40.46	19.7	35.1	28.07	5.30
White clover hay	2	91.4	92.9	92.12	14.1	20.0	17.03	2.1	5.8	3.95	38.2	40.6	39.38	20.3	27.3	23.75	8.00
Alsike clover hay	4	91.6	94.8	92.63	11.4	16.1	13.50	1.6	4.2	2.35	36.5	43.5	40.86	27.7	29.5	28.61	7.31
Lucerne hay	3	92.5	94.4	93.52	15.0	18.6	17.04	1.8	2.4	2.05	35.5	39.2	37.12	26.2	33.0	30.21	7.10
Timothy hay, (*Pleum pratense*)	53	84.5	92.9	89.76	4.2	9.6	6.06	1.0	3.4	2.12	39.2	58.5	47.10	22.7	38.5	30.37	4.11
Red top hay, (*Agrostis vulgaris*)	1	-	-	90.16	-	-	7.25	-	-	1.95	-	-	46.52	-	-	27.45	6.99
Timothy and red top	10	85.7	91.8	87.64	4.8	9.0	6.52	1.5	2.7	2.00	38.5	48.9	44.15	24.7	38.4	30.17	4.80
Orchard grass hay, (*Ductylis glomerata*)	4	88.2	93.5	91.87	3.6	8.2	6.33	1.4	2.4	1.93	33.5	48.6	44.45	29.7	38.3	33.81	5.35
Hungarian grass hay	13	91.0	95.2	92.85	5.0	12.3	7.22	1.5	3.5	2.14	44.4	53.0	49.41	23.6	31.3	28.25	5.83
Barley hay, seed in milk	1	-	-	89.75	-	-	9.21	-	-	2.47	-	-	47.49	-	-	26.14	4.44
Oat hay	3	86.3	91.3	89.32	7.8	9.9	8.53	2.1	3.1	2.52	36.2	48.0	41.93	25.1	33.6	29.92	6.42
High meadow hay	2	88.7	89.4	89.02	6.8	8.3	7.57	2.0	2.5	2.25	46.9	47.5	47.19	24.3	25.2	25.78	6.23

Hay from mixed meadow grasses	9	81 0	87.0	84.52	4.9	7.9	6.24	1.4	2.7	2.05	34.4	47.3	40.43	23.7	35.9	31.09	4.71
Low meadow hay	10	85.5	93.6	89.50	4.6	10.4	7.70	.7	3.6	2.20	39.8	55.2	43.60	21.4	40.0	30.20	5.80
Hay from salt marsh grasses	13	81.4	92.8	89.89	4.0	7.8	5.69	1.6	3.1	2.31	34.1	54.3	44.10	25.1	37.9	30.51	7.28
Baled hay, extra fine	1	-	-	84 05	-	-	6.20	-	-	2.19			45.13	-	-	26.60	3.93
Maize fodder, field cured	4	60.6	77.1	65.02	3.8	4.6	4.23	.6	1.6	1.08	30.5	40.8	33.79	18.7	24.7	21.27	4.65
Maize stover, field cured.	9	63.5	83.8	77.17	3.8	8.3	5.38	1.1	1 9	1.45	35.8	46.2	40.30	19.1	29.5	25.18	4.86
8 Maize stover. dried	11	87.0	92.4	90.43	3 4	8.5	5.02	.8	1.5	1.10	45.3	52.9	49.17	26.6	33.6	29 92	5.23
Buckwheat straw	3	89.6	91.0	90.09	3.3	7.8	5.15	.7	1.7	1.26	32.1	38.9	35.16	37.2	46.8	42.98	5.54
Oat straw	12	87.5	93.5	91.26	2.3	6.9	3.82	1.0	3.2	2.22	26.4	51.4	38 89	29.5	56.0	41.52	4.81
Rye straw	8	87.5	93.7	92 24	2.2	6.9	3.46	1.0	2.7	1.40	35.7	52.9	38.35	34.2	43.3	45.25	3.78
Wheat straw	6	82.1	93.5	91.22	2.9	5.0	3.45	.8	1.8	1.29	31.0	50.6	37.33	34.3	42.7	44.99	4.16
Cow-pea vines	6	86.0	90.7	85.95	13.6	19.8	15.68	1.1	4.1	2.87	34.9	46.4	42.17	17.2	23.7	19.80	8.41
ROOTS, BULBS, TUBERS AND OTHER VEGETABLES AND FRUITS.																	
Beets, red	2	10.5	12.3	11.43	1.5	1.7	1.60	.2	.2	.18	7.2	7.6	7.40	.6	1.7	.12	1.08
Beets, sugar	8	9.2	16.4	13.03	1.7	2.9	2.01	1.	.2	.10	5.7	12.0	9 15	.7	1.1	.87	.90
Mangolds	6	5.6	11.7	8.68	1.0	1.9	1.52	-	.5	.16	2.4	8.4	5.00	.8	1.0	.84	1.16
Rutabagas	1	-	-	12.92	-	-	1.15	-	-	.09	-	-	9 11	-	-	1.16	1.41
Turnips	2	7.6	8.2	7.92	.8	1.3	1.02	.1	.2	.18	5.8	4.2	5.03	.8	1.2	1.01	.68
Carrots	6	8.9	13.5	11.70	.9	2.0	1.16	.2	.7	.42	5.1	10.4	7.68	1.0	2.3	1 38	1.06
Onions	6	6.5	18.4	12.45	.8	2.3	1.41	.2	.4	.26	3.8	14.6	9 53	.6	.8	.69	.56
Potatoes	7	19.4	24.1	21.90	1.1	3 0	2.19	-	.2	.10	15.3	26.0	18.19	.3	.9	.54	.88
Sweet potatoes	5	26.6	34.0	29.37	.5	3.6	1.55	.3	.6	.38	18.0	29.7	25.09	.6	2.5	1.36	99
Cabbage	2	6.5	10.2	8.28	1.8	2.0	1.95	.2	.5	.33	2.0	3.5	2.75	1.4	3.0	2.21	1.04
Squash	2	4.8	5.4	5.12	.6	.6	.66	.2	.3	.28	2.9	3.5	3.24	.5	.5	.54	.40
Pumpkin	1	-	-	7.73	-	-	1.11		-	.16	-	-	4 34	-		1.49	.63
Apples	5	15.9	22.7	18.22	.2	1.2	.69	.3	.6	.41	12.6	20.0	15.31	.9	2.9	1.49	.32
GRAIN AND OTHER SEEDS.																	
Barley	9	87.4	92.7	89.08	8.6	15.7	12.39	1.5	3.1	1.86	66.7	73.9	69.88	1.2	4.1	2.57	2.38
Buckwheat	8	85.1	89.1	87.40	8.6	11.1	10.00	2.2	2.4	2.25	62.6	65.4	64.50	7.8	9.4	8.70	2.00
Oats (raised in Connecticut)	7	86.5	90.7	89.06	8.0	10.1	9.32	4.7	5.8	5.29	59.0	63.2	61.55	8.9	12.9	9.95	2 95
Oats	25	86.5	91.1	89.06	8.0	14.4	11.38	3.4	5.8	4.81	50.8	66.9	60.05	1.5	19.4	9.85	2.97
Rye	6	86.8	91.3	88.40	9.5	12 1	10.60	1.4	2.1	1.70	70.7	73.9	72.60	1.4	2.[illegible]	1.60	1.90
Wheat, winter	242	83.8	92.9	89.48	8.3	16.6	11.73	1.3	3.9	2.11	68.1	76.6	72.01	.4	2.9	1.77	1.86
Wheat, spring	13	86.6	91.9	89 63	8.1	15.4	12.51	1.8	2.5	2.20	66.1	78.6	71.19	1.3	2.3	1.82	1.91
Wheat, unclassified	55	87.6	90.9	89.31	9.8	14.7	11.96	1.6	2.8	2.10	68.5	74.7	71.50	1.2	3.1	1.92	1.83
Wheat, average of all analyses	310	83.8	92.9	89.46	8.1	16.6	11.80	1.3	3.9	2.11	66.1	78.7	71.89	.4	3.1	1.80	1.86

Name.	Analyses.	Total Dry Matter.			Albuminoids or Protein.			Crude Fat.			Nitrogen-free Extract.			Fiber.			Ash.
		Min.	Max.	Average.	Min.	Max.	Average.	Min.	Max.	Average	Min.	Max.	Average.	Min.	Max.	Average.	
GRAIN AND OTHER SEEDS.																	
Maize, dent	80	85.9	93.7	89.91	7.5	12.1	10.33	3.8	6.9	5.10	66.2	75.7	70.66	1.2	4.8	2.28	1.54
" flint	70	80.4	93.4	88.93	7.0	13.7	10.57	3.4	7.1	4.96	65.0	74.6	70.31	.7	2.9	1.65	1.44
" sweet	26	89.1	94.0	91.18	9.5	15.3	11.62	3.8	11.9	8.14	61.8	72.4	66.70	1.5	5.2	2.80	1.92
" "western corn"	3	79.3	93.6	80.90	7.8	8.6	8.30	3.6	3.9	3.70	64.9	68.2	66.00	1.7	1.8	1.75	1.20
" averages of all analyses	192	79.3	94.0	89.49	7.0	15.3	10.55	3.4	11.9	5.45	61.8	75.7	69.85	.7	5.2	2.09	1.54
Sorghum seed	9	83.2	90.7	87.48	7.6	11.2	8.88	2.1	4.6	3.65	66.8	73.6	71.26	1.4	3.2	1.88	1.80
Cotton seed, hulls and kernels	1	-	-	92.28	-	-	15.72	-	-	18.56	-	-	29.09	-	-	25.73	3.16
Cow pea	5	79.2	89.9	85.21	19.3	23.0	20.77	1.3	1.6	1.43	48.1	61.9	55.75	3.3	5.0	4.06	3.20
Soy bean	4	86.9	93.9	91.53	34.6	40.2	37.22	12.3	19.0	16.52	26.2	30.5	28.21	3.7	5.0	5.12	4.46
FLOUR AND MEAL.																	
Barley meal	3	83.8	86.0	84.90	8.8	13.9	11.80	.7	2.2	1.70	-	-	70.90	-	-	.10	.50
Buckwheat flour	4	82.4	87.2	85.46	4.2	8.1	6.89	.7	1.8	1.44	71.1	79.4	75.79	.2	.5	.34	1.00
Oat meal	6	91.1	93.8	92.15	12.9	16.2	14.66	6.1	8.8	7.06	66.6	68.9	67.57	.6	1.2	.86	2.00
Rye flour	4	86.4	87.7	86.90	6.0	7.1	6.65	.8	.9	.84	77.6	79.1	78.28	.4	.5	.41	.72
Wheat flour, from winter wheat	1	-	-	87.04	-	-	8.56	-	-	1.19	-	-	76.59	-	-	.17	.53
" " spring wheat	6	86.5	89.7	87.68	8.6	14.1	10.68	.6	2.0	1.11	68.3	78.1	75.00	-	1.2	.22	.64
" " unclassified	21	86.4	88.8	87.52	9.7	13.3	11.25	.8	1.9	1.16	69.5	76.9	74.33	.1	1.0	.25	.53
" averages of all varieties	25	86.4	89.7	87.44	8.6	14.1	11.28	.6	2.0	1.20	68.3	78.1	74.13	.0	1.2	.27	.56
Graham flour	3	86.3	87.9	86.90	11.3	12.4	11.70	1.5	1.9	1.70	69.8	70.0	69.80	1.8	2.1	1.90	1.80
Maize meal	56	74.5	92.0	84.15	7.1	10.3	9.16	2.2	5.1	3.81	57.0	74.0	67.81	.5	2.8	1.80	1.46
Hominy	2	86.4	86.6	86.50	8.1	8.4	8.25	.4	.5	.44	77.1	77.2	77.12	.3	.3	.32	.38
Sorghum meal, mostly decorticated	1	-	-	86.84	-	-	8.25	-	-	3.85	-	-	71.27	-	-	1.88	1.59
Pea meal	2	87.0	91.2	89.54	19.1	21.4	10.23	.9	1.5	1.19	50.2	52.0	51.09	11.1	17.7	14.33	2.64

BY PRODUCTS AND REFUSE.																	
Apple pomace	7	22.1	27.4	22.94	1.0	1.7	1.40	.6	2.0	1.36	12.6	17.6	15.63	2.0	5.9	4.01	.54
Brewers' grains, wet from brewery	15	20.6	31.4	24.99	4.3	7.7	5.57	.8	2.9	1.68	10.1	15.7	12 86	3.0	5.6	3.87	1.01
" dried	3	88.1	93.8	91.81	19.2	20.2	19.89	4.2	6.5	5.56	46.1	56.8	51.75	10.2	11.6	11.01	3.58
" kiln dried	1	-	-	97.43	-	-	20.30	-	-	6.40	-	-	54.89	-	-	11.79	3.97
" from silo	3	26.1	33.2	30.18	5.8	7.1	6.64	1.8	2.5	2.11	13.6	16.8	15.58	3.9	5.4	4.64	1.21
Brewers' swill	1	-	-	5.70	-	-	1.90	-	-	.80	-	-	2.00	-	-	.70	.30
Malt sprouts	3	88.0	92.7	89.72	21.0	25.9	22.95	1.1	2.9	1.79	45.4	50.3	48.60	9.3	11.9	10.72	5.67
Cotton seed meal	29	81.5	94.2	91.68	23.3	50.8	42 39	10.2	18.0	13.37	12.7	38.6	22.97	2.7	11.7	5.69	7.26
Linseed meal, old process	12	87.4	93.9	90.97	27.7	38.2	32.33	5.1	11.6	8.24	30.8	41.9	35.22	7.1	13.3	9.31	5.87
" new "	12	86.6	93.2	89.25	27.1	37.1	32.85	1.3	4.4	3.08	35.2	48.0	38.29	7.6	14.0	9.46	5.57
" oil not removed	1	-	-	91.67	-	-	22.97	-	-	30.26	-	-	25.48	-	-	9.60	3.36
Palm nut meal	3	89.1	93.8	91.71	13.5	16.0	14 39	6.4	18.7	13.30	33.8	41.6	38.88	18.7	23.9	21.40	3.74
Rye bran	6	86.3	91.8	88.51	11.5	16.8	15.28	1.8	4.9	2.46	59.8	67.6	63.66	2.5	4.1	3.52	3.59
Wheat bran	63	84.2	91.8	87.72	7.5	16.9	15.07	1.5	5.9	3.78	50.0	67.6	54.26	2.4	17.8	8.71	5.70
" middlings	27	84.0	91.5	88.00	10.1	19.2	15.17	1.3	12.7	4.01	53.0	70.9	60.99	2.1	5.9	4.57	3.26
" shorts	8	84.5	89.0	87.26	11.1	16.1	13.83	2.5	5.3	4.14	53.3	67.0	57.59	5.8	10.5	7.45	4.25
Hominy chops, hominy feed, Baltimore meal, white meal	11	86.5	91.9	88.86	7.9	11.2	9.85	4.6	11.2	8.43	61.0	71.1	64.49	2.5	4.8	3.59	2.50
Gluten meal	11	88.3	92.7	90.61	25.0	35.0	29.58	4.2	8.7	6.31	44.7	58.5	52.64	.7	3.8	1.34	.74
Maize cob	13	85.6	92.8	90.67	1.2	3.7	2.50	.1	.9	.45	45.3	66.4	55.99	28.2	38.2	30.36	1.33
Starch feed, refuse from starch manufacture	8	27.8	37.7	34.34	3.6	7.7	5.73	1.3	4.3	3.02	18.7	28.9	22.21	1 6	4.3	3.17	.21
Sugar feed, kiln dried, refuse from glucose	2	89.6	93.4	91.50	13.1	13.5	13.30	5.9	11.2	8.60	54.9	61.4	58.10	8.4	10.7	9.50	2.00
Sorghum bagasse	4	11.3	16.6	14.50	.6	.7	65	-	-	-	-	-	10.20	2.8	3.3	3.10	.60

Digestibility of American Feeding Stuffs.

Very few determinations of the digestibility of American products have yet been made, and so we are still obliged to use German figures. These are sufficiently accurate, without doubt, so far as they apply to the grains and such by products as bran, cotton seed meal, &c., but in the case of the hays, coarse fodders and similar materials, the percentage as stated for European products will probably be modified.

DIGESTIBILITY OF FEEDING STUFFS—DIGESTION COEFFICIENTS.

	No samp's tes'd	No of e. periments.	Total dry organic matter.			Albuminoids or Protein.			Crude Fat.			Nitrogen free Extract.			Fiber.		
			Min.	Max.	Aver'ge	Min.	Max.	Averg'e	Min.	Max.	Aver'ge.	Min.	Max.	Aver'ge.	Min	Max.	Aver'ge.
GREEN FODDER.																	
Pasture grass	3	6	75	78	77.00	72	79	75.00	63	69	66.00	75	84	78.00	72	80	75.00
Meadow grass (experiments with horses)	10	13	43	62	50.00	54	69	61.00	9	42	21 00	49	66	57.00	33	57	41.00
Meadow rowen	6	30	62	71	64.00	61	68	62.00	31	56	46.00	63	74	66.00	59	68	64.00
Pasture clover, very young	1	2	-	-	75.00	-	-	78.00	-	-	64.00	-	-	78.00	-	-	67.00
Red clover, just before blossoming	6	15	59	74	66.00	60	76	66.00	58	74	64 00	63	83	73.00	47	60	53.00
Lucerne, before flower ng and in flower	9	28	55	67	60 00	67	83	74.00	29	55	39.00	61	73	67.00	34	48	43 00
Vetches	-	-	-	-	-	73	85	76.00	50	66	60 00	63	67	65.00	51	58	54.00
Lupine	-	-	-	-	-	73	76	74.00	16	45	30.00	57	66	62.00	67	80	73.00
Maize fodder (very good)	1	1	-	-	70.00	-	-	73.00	-	-	75.00	-	-	67.00	-	-	72.00
Sorghum	1	1	-	-	73.00	-	-	62.00	-	-	85.00	-	-	78.00	-	-	59.00
Beet l aves (ensilaged)	1	2	-	-	57.00	-	-	65.00	-	-	60.00	-	-	54.00	-	-	54.00
Beans, peas, cabbage																	
Turnip leaves, parsnip leaves	-	-	-	-	-	-	-	71.00	-	-	60.00	-	-	100.00			
Fodder rye, fodder oats																	
Beet leaves, carrot leaves, buckwheat	-	-	-	-	-	-	-	58.00	-	-	46.00	-	-	100.00			
Meadow hay	38	101	46	71	62.00	42	72	62.00	10	63	52.00	49	76	64.00	46	71	57.00
Meadow hay (very good)	14	42	56	71	65.00	57	70	64.00	31	63	50.00	58	76	68.00	55	71	62.00
Meadow hay (medium)	24	62	46	69	60.00	42	72	57.00	10	63	48.00	49	73	62.00	46	66	58.00
HAY.																	
Meadow hay (inf rior)	7	18	46	59	55.00	42	56	51.00	10	57	41.00	49	61	58.00	46	61	54.00
Meadow hay (very good, experiments on horse)	3	4	49	55	52.00	63	66	64.00	11	42	24.00	52	62	57.00	36	46	43.00
Meadow hay (medium, xperimonts on horse)	5	6	43	51	48.00	54	62	58.00	16	33	23.00	49	61	55.00	33	40	37.00
Clover hay (very good)	6	12	58	63	61.00	55	69	62.00	41	72	60.00	67	72	70.00	39	52	47.00
Clover hay (medium)	6	19	54	62	57.00	43	61	55.00	35	70	51.00	58	67	65.00	39	52	45.00
Clover hay (experiments on horse)	4	6	49	55	51.00	51	60	56 00	28	31	29.00	61	67	64.00	35	39	37.00
Lucerne hay (very good)	9	28	55	67	60.00	67	83	74.00	29	55	39 00	61	73	66.00	34	48	43.00
Hay of fodder vetches (before blossom)	1	6	-	-	65.00	-	-	76.00	-	-	60.00	-	-	66.00	-	-	54.00
Lupine hay, in blossom	1	2	-	-	-	-	-	74.00	-	-	30.00	-	-	62.00	-	-	74.00

DIGESTIBILITY OF FEEDING STUFFS—DIGESTION COEFFICIENTS.

	No. samples tested	No. of experiments.	Total dry organic matter			Albuminoids or Protein.			Crude Fat.			Nitrogen free Extract.			Fiber.		
			Min.	Max.	Average.	Min.	Max.	Average.	Min.	Max	Average.	Min.	Max.	Average.	Min.	Max.	Average.
Roots.																	
Potatoes	3	23	83	90	88.00	64	67	65.00	-	-	-	89	96	93.00			
Potatoes (experiments with pigs)	5	8	-	-	93.00	-	-	73.00	-	-	-	-	-	98.00	-	-	55.00
Sugar beets	2	28	84	93	89.00	56	68	62.00	-	-	-	95	96	95.00			
Mangolds	2	16	·87	88	88.00	66	86	76 00	-	-	-	94	96	95.00			
Turnips)	1	8	-	-	78.00	-	-	57.00	-	-	-	-	-	89 00			
Grains.																	
Oats	6	31	62	74	68.00	68	86	77.00	75	97	82.00	67	79	74.00	-	26	17.00
Oats (experiment with horse)	1	5	-	-	72.00	-	-	86.00	-	-	78.00	-	-	76.00	-	-	24.00
Barley	1	2	-	-	81.00	-	-	77.00	-	-	100.00	-	-	87.00			
Barley (experiment with horse)	1	.	-	-	87.00	-	-	80.00	65	-	42.00	-	-	87 00	-	-	100 00
Barley (experiments with pig)	4	8	82	85	83.00	75	80	78.00	-	77	68.00	89	91	90.00	-	27	12.00
Maize	1	2	-	-	89.00	-	-	79.00	-	-	85.00	-	-	91.00	-	-	62.00
Maize (experiments with horse)	1	1	-	-	91.00	-	-	78.00	76	-	63.00	-	-	94.00	-	-	100.00
Maize (experiments with pig)	3	4	90	95	92.00	84	88	86.00	65	77	76.00	93	96	95.00	19	57	40.00
Field beans	5	18	83	94	89.00	81	95	88.00	-	100	87.00	88	95	92.00	25	92	72.00
Field beans (experiment with horse)	1	4	-	-	87.00	-	-	86.00	-	-	-	-	-	93.00	-	-	69.00
Peas	1	2	-	-	90.00	-	-	89.00	-	-	75.00	-	-	93.00	-	-	66.00
Peas (experiment with horse)	1	1	-	-	80·00	-	-	83.00	36	-	67.00	-	-	89.00	-	-	8.00
Peas (experiments with pigs)	5	10	88	95	91.00	85	90	88.00	.	67	49.00	95	99	96.00	55	89	71.00
By Products and Refuse.																	
Wheat bran (fed dry)	5	12	67	78	72.00	71	89	78·00	50	80	69.00	70	82	77.00	20	39	33.00
Rye bran (experiments with pigs)	1	2	-	-	67.00	-	-	66.00	-	-	58.00	-	-	75.00	-	-	4.00
Malt sprouts	1	3	-	-	84.00	-	-	82.00	-	-	49.00	-	-	88.00	-	-	95.00
Brewer's grains	1	2	-	-	63.00	-	-	73.00	-	-	84.00	-	-	64.00	-	-	39.00
Rape meal (oil extracted)	1	1	-	-	6.00	-	-	84.00	-	-	-	-	-	85.00			
Rape cake	2	7	56	75	66.00	76	86	81.00	69	88	79.00	74	78	76.00	-	16	8.00

Linseed meal (oil extracted)	1	8	-	-	71.00	-	-	82.00	-	-	91.00	-	-	73.00		-	
Linseed cake	2	10	78	83	81.00	84	87	86.00	89	91	90.00	70	91	80.00	26	62	44.00
Palm nut meal (oil extracted)	2	3	89	93	91.00	89	100	95.00	89	100	95.00	92	96	94.00	72	92	82.00
Cotton seed cake (decorticated)	1	2	-	-	80.00	-	-	85.00	-	-	88.00	-	-	95.00	72	-	
Cotton seed cake (not decorticated)	1	4	-	-	50.00	-	-	73.00	-	-	91.00	-	-	46.00	-	-	23.00
Cocoanut cake	1	2	-	-	78 00	-	-	76.00	-	-	100.00	-	-	81.00	-	-	62.00
Cocoanut cake (experiments with pigs)	1	2	-	-	80.00	-	-	74.00	-	-	83.00	-	-	89.00	-	-	60.00
Flesh meal	1	2	-	-	95.00	-	-	95.00	-	-	98 00						
Flesh meal (experiments with pigs)	1	8	-	-	95.00	-	-	97.00	-	-	87.00						
Blood meal	1	2	-	-	63.00	-	-	62.00	-	-	100.00	-	-	100.00			
Blood meal (experiments with pigs)	1	1	-	-	72.00	-	-	72.00	-	-	-	-	-	92.00			
Fish Guano	1	2	-	-	-	-	-	90.00	-	-	76.00						
STRAW.																	
Wheat straw	2	3	45	48	46.00	8	26	17.00	27	44	36.00	37	40	39.00	52	59	56.00
Wheat straw (experiments with horse)	1	2	-		23.00		-	19.00	-	-	49.00	-	-	17.00	-	-	27.00
Rye straw	2	9	42	51	46.00	17	25	21.00	-	-	32.00	35	38	37.00	49	70	60.00
Oat straw	4	8	48	56	51.00	24	48	41.00	20	49	30.00	39	45	46.00	55	64	60.00
Barley straw	2	5	51	55	53.00	17	24	20.00	41	43	42.00	51	57	54.00	55	56	56.00
Pea straw (very good)	1	2	-		59.00	-	-	61.00		-	46.00		-	64.00	-	-	52.00
Bean straw	1	3	-		50.00	-	-	51.00		-	55.00		-	63.00	-	-	36.00
Lupine straw	1	2	-		55.00	-	-	37.00		-	30.00		-	65.00	-	-	51.00

The figures given in the foregoing tables have cost a great deal in time and money, and they should be made useful. It seems to be the custom for farmers to request those familiar with these tables and their use to make up for them from certain specified materials a ration adapted to a particular purpose. This is not necessary. A person who has had the average training in mathematics which our public schools give can by the use of the previous tables calculate a new ration, or ascertain how the one he is feeding compares with the standard.

Perhaps the following calculations may serve to make plain the manner in which this is done. It is a question we will suppose whether the following ration is correct for a one thousand pound milch cow.

40 lbs. maize ensilage,
10 " Timothy hay,
4 " corn meal,
2 " wheat bran.

Looking in the table of fodders analyses we find what is the composition of ensilage, and in the table of digestibility of feeding stuffs under green fodder we find the digestibility of green maize fodder, which differs but little, if any, from the digestibility of ensilage. Using these two sets of figures we can calculate the pounds of digestible material in 100 pounds of the food.

	Ensilage In 100 lbs.		Per cent Digestible.		Pounds in 100.
Organic matter	18 2	×	70	=	12 74
Protein	1.50	×	73	=	1.09
Fat	.68	×	75	=	.51
Nitrogen free extractive matter	10.26	×	67	=	6 87
Crude fiber	5.68	×	72	=	4.09

By the same method we ascertain the digestible material in a hundred pounds of the other feeding stuffs in our ration, and these are as follows:

DIGESTIBLE IN ONE HUNDRED POUNDS.

	Organic Matter.	Protein	Fat.	Nitrogen Free Extractive Matter.	Crude Fiber.
Ensilage	12.74	1.09	.51	6 87	4.09
Timothy Hay	39.39	3.45	1.03	29.20	17.61
Corn Meal	78.67	8.16	4.33	64.30	1.41
Wheat Bran	60.48	11.75	2.61	41.78	2.87

These are the quantities of digestible ingredients in 100 pounds of the different feeding stuffs. A determination of what our ration will furnish is now a simple matter. For instance 40 pounds of ensilage contains four-tenths as much as 100 pounds, so we have:

Organic matter........................	12.74 × 4-10 = 5.10
Protein...............................	1.09 × 4-10 = .436
Fats..................................	.51 × 4-10 = .20
Nitrogen-free extractive matter	6 87 × 4-10 = 2.75
Crude fiber...........................	4 09 × 4-10 = 1 64

A similar calculation for the hay, meal and bran gives the following figures:

DIGESTIBLE MATERIAL IN PROPOSED RATION.

	Organic matter.	Protein.	Fats.	Nitrogen-free extractive matter.	Crude fiber.
Ensilage, 40 lbs..............	5.10	.436	.20	2.75	1.63
Timothy hay, 10 lbs............	5.13	.345	.10	2.92	1.76
Corn meal, 4 lbs...............	3.15	.326	.17	2.57	.06
Wheat bran, 2 lbs..............	1.18	.235	.05	.84	.06
Total..........................	14.56	1.342	.52	9.08	3.51

A comparison, shows this ration to be widely different from the German standard.

	Proposed ration.	German ration.
Organic matter (total nutrients)......	14.45	15.40
Protein...............................	1.32	2.5
Nitrogen-free extract and fiber.......	12.59	12.5
Fats..................................	.52	.40
Nutritive ratio.......................	1:10 3	1:5.4

The proposed ration differs from the German standard mainly in having a much less quantity of digestible protein, the total digestible material being somewhat less also.

While it is doubtful if feeding 2.5 pounds of protein would be good economy, but little over half that amount is undoubtedly too small a quantity to secure the most profitable results. It is evident that the thing to do is to feed for a portion of the grain ration some material more nitrogenous than the corn meal or bran. Cotton-seed meal, linseed meal, pea meal and gluten meal are some of the foods, any one of which would serve to amend the ration. Let us calculate the ration with three pounds of cotton-seed meal put in the place of two of the four pounds of corn meal.

DIGESTIBLE MATERIAL IN AMENDED RATION.

	Organic matter.	Protein.	Fats.	Nitrogen-free extractive matter.	Crude fiber.
Ensilage, 40 lbs	5.10	.436	.20	2.75	1.63
Timothy hay, 10 lbs	5.13	.345	.10	2.92	1.76
Corn meal, 2 lbs	1.57	.163	.08	1.28	.03
Cotton seed meal, 3 lbs	2.20	1.07	.35	.66	
Wheat bran, 2 lbs	1.18	.235	.05	.84	.06
Total	15.18	2.249	.78	8.45	3.48

Even now our ration is not strictly in accordance with the standard, but it is probably as nitrogenous as is advisable. In fact, the practical tests of the German feeding standards which have been made within the past few years, show that a ration may be very efficient when it differs from them considerably. These standards furnish a good working basis, however, not only for practical feeding experiments, but also for scientific investigation in matters pertaining to the feeding of farm animals. Fixed standards for the guidance of cattle feeders may certainly be made useful, and whether the German formulas are approximately correct or not, they surely are a long step in the direction of practice based upon scientific principles. It is because of the prominent place the so-called German rations have in the current discussions concerning the feeding of live stock, and because these rations furnish valuable suggestions to stock growers and dairymen, that they are given here and their use explained. The farmer who understands the purpose and meaning of these rations, and the general principles upon which they are based, is prepared to quickly grasp and apply the better knowledge to which they may lead.

TESTS OF VARIETIES.

The Experiment Station tested in the summer of 1886 a number of varieties of potatoes, oats and barley. (See Station Report 1886-7, pp. 104, 107.) The same varieties, with some additions were again grown in 1887 and 1888, also a large number of varieties of peas. The results of the year 1887 were reported in Experiment Station Bulletin No. 24. But as they have not appeared in the annual report of the station they are reported here with the trials of 1888.

POTATOES.

Report of Trials in the Year 1887.

The varieties of potatoes were planted on a loam, somewhat lighter and less clayey, than the college farm in general, a soil uniform in character and well adapted to hoed crops. This piece of ground was manured, after plowing the previous fall, with about ten cords of good stable manure per acre, and in the spring a small quantity (300 lbs. per acre) of a mixture of dissolved bone black and muriate of potash was spread broad-cast. Each variety occupied a row ninety feet long, containing sixty hills, the hills being eighteen inches apart and the distance between the rows, three and one-half feet. In each hill was planted a piece of potato having three good eyes. All the rows were carefully cultivated at the same time and in the same manner.

Injury by the potato beetle was carefully guarded against by the use of Paris green, and it can be said that the trial was not disturbed by mishap of any kind, the growth of the plants being very uniform and satisfactory.

In the tables which follows are recorded:

(1) The date on which each variety was first noticed to blossom, this being an indication of the time of maturing.

(2) The yield of large and small potatoes per row, and per acre (calculated), also the total yield.

The date of planting was May 18th and 19th. It was intended to record the date at which the tops began to die as an indication of ripeness, but this was rendered impossible by the fact that the tops of all the varieties remained green until the date of digging, September 12th and 13th. All the varieties were comparatively free from scab or rot, and all presented a fine appearance when dug. No test of quality for eating has been made of these varieties, but the coming season an attempt will be made to do this.

No	Potatoes. Name of Variety.	First Blossoms Seen.	Yield per Plot.			Yield per Acre.		
			Large.	Small.	Total.	Large.	Small.	Total.
			lbs	lbs.	lbs.	bush.	bush.	bush.
1	Thorburn	June 27	97	25	122	223	58	281
2	Clark's No. 1	July 1	91	10½	101½	210	24	234
3	Rose Magnum Bonum	" 4	50¾	15½	66.25	117	35	152
4	Early Ohio	" 6	89¼	8¼	97.50	207	19	224
5	Early Maine	" 4	62½	12	74.5	144	27	171
6	Early Vermont	June 27	73½	11¼	84 75	169	25	195
7	Watson's Seedling	July 4	68½	11	19.5	157	25	183
8	Vanguard	" 18	86	9½	95.5	199	21	220
9	Eight Weeks	" 16	120	18	138	276	41	317
10	Early Sunrise	" 18	59¾	11	70.75	137	26	163
11	Pearl of Savoy	" 1	91½	13¾	105 25	210	32	242
12	Hale's Early Peach Blow	" 8	70½	5	75.5	162	12	174
13	Triumph	" 11	112	13½	225.5	258	31	289
14	Early Essex	" 4	83½	19	102.5	192	44	236
15	Beauty of Hebron	" 4	86½	23	109.5	199	53	252
16	Orange Co. White	" 21	151	8	159	348	18	366
17	Dunmore	" 30	148	11½	159.5	341	26	367
18	Queen of the Roses	" 4	99	23	122	228	53	281
19	Rural Blush	" 18	136	5¼	141.5	313	12	325
20	Garfield	" 4	159	7½	166.5	366	17	383
21	Improved White Rose	" 18	97	9	106	223	21	244
22	White Star	" 20	114	3	117	262	7	269
23	St. Patrick	" 11	119½	6½	126	275	15	290
24	Vermont Champion	" 28	129	9¼	138.5	297	21	318
25	Belle	" 11	112	4½	116.5	258	11	269
26	Rochester Favorite	" 20	70	3	73	161	7	168
27	Perfect Peach Blow	" 13	82	9	91	189	20	209
28	Charter Oak	" 11	96½	7	103.5	222	16	238
29	Great Eastern	" 30	125½	7	132.5	289	16	305
30	Dictator	" 30	81	7½	88.5	186	18	204
31	Empire State	" 5	89	11½	100.5	205	26	231
32	Burbank Sport	" 18	107½	5½	113	247	13	260
33	Dakota Red	" 6	112½	5	117.5	259	11	270
34	Thorburn's Late Rose	" 6	112	4½	116.5	158	10	268
35	Late Beauty of Hebron	" 4	104½	10¾	115.2	240	25	265
36	O. K. Mammoth Prolific	" 29	126½	10	136.5	291	23	314
37	White Elephant	" 6	138	5	143	318	11	329
38	Red Elephant	" 21	85	5	90	196	11	207
39	Jumbo	" 29	126	6	132	290	14	304
40	White Seedling	" 18	143	1½	144.5	330	3	333
41	Monroe Co Prize	" 14	158½	3	161.5	365	7	372
42	Roses New Giant	" 12	132	13	145	304	30	334
43	Roses Beauty of Beauties	" 28	125½	9½	135	289	22	311
44	Jackson White	" 18	77	3	80	177	7	184
45	Early Goodrich	" 18	130	5½	135.5	299	13	312
46	Morning Star	" 11	185½	5	190.5	428	11	439
47	Gregory's (No Name)	" 18	36¾	1½	38.25	253	10	263

Report of Trials for 1888.

The varieties of potates were planted this year in soil similar in character to that on which the potatoes were planted in 1887. The land had been cropped the previous year. At the time of planting 600 pounds of a reliable superphosphate were applied per acre.

The varieties were planted in rows three feet apart and 180 feet long, each row representing one-eightieth of an acre. Otherwise the conditions were the same as for the preceding year.

Number.	Potatoes—Variety.	Date of planting.	Date of blossoming.	Date of tops dying.	Date of harvesting.	Weight of large potatoes.	Weight of small potatoes	Total weight	Total yield per acre in bushels.
						lbs	lbs.	lbs.	
1	Thorburn	May 24,	July 14,	Tops remained green up to September 7, when they were killed by frost.	Sept. 24,	109½	22½	132	176
2	Clark's No. 1	" "	" 16,		" "	110	11	121	161⅓
3	Rose Magnum Bonum	" "	" 14,		" "	119½	9½	129	172
4	Early Ohio	" "	" 19,		" 25,	104	8½	112½	150
5	Early Maine	" "	" 16,		" "	82	14	96	126
6	Early Vermont	" "	" 16,		" "	74	20	94	125⅓
7	Watson's Seedling	" "	" 14,		" "	102	11	113	150⅔
8	Vanguard	" "	" 13,		" "	101	18	119½	159⅓
9	Eight Weeks	" 25,	" 19,		" "	142½	16	158½	211⅓
10	Early Sunrise	" "	" 13,		" "	108½	20	128½	171⅓
11	Pearl of Savoy	" "	" 13,		" "	165½	15	180½	240⅔
12	Hale's Early Peach Blow	" "	" 19,		" "	104	3½	107½	143⅓
13	Triumph	" "	Aug 4,		" "	91	17	108	144
14	Early Essex	" "	July 13,		" "	95	27	122	162⅔
15	Beauty of Hebron	" "	" 13,		" "	62	27	89	118⅔
16	Orange County White	" "	" 21,		" "	134½	10½	145	193⅓
17	Dunmore	" "	Aug. 7,		" "	247	17	264	352
18	Queen of the Roses	" "	July 14,		" 26,	163	22	185	246⅔
19	Rural Blush	" "	" 19,		" "	202	11	213	284
20	Garfield	" "	" 16,		" "	201	18½	219½	292⅔
21	Improved White Rose	" "	" 21,		" "	131½	16	145½	194
22	White Star	" "	Aug. 1,		" "	146	9	155	206⅔
23	St. Patrick	" "	July 16,		" "	186	10	196	261⅓
24	Vermont Champion	" "	Aug. 3,		" 28,	157½	22	179½	239⅓
25	Belle	" "	July 17,		" "	142½	17	159½	212⅔
26	Rochester Favorite	" "	Aug. 1,		" "	121½	9	130½	176
27	Perfect Peachblow	" "	July 20,		" "	139	19	158	210⅔
28	Charter Oak	" "	" 23,		" "	165	25	190	253⅓
29	Great Eastern	" "	Aug. 6,		" "	190½	18	208½	278
30	Dictator	" "	" 8,		" "	150½	12½	163	217⅓
31	Empire State	" "	July 14,		" "	169½	16	175½	234
32	Burbank Sport	" "	" 17,		" "	154	8½	162½	216⅔
33	Dakota Red	" "	" 23,		" "	165	5	170	226⅔
34	Thorburn's Late Rose	" "	" 16,		" "	210½	9	219½	292⅔
35	Late Beauty of Hebron	" "	" 16,		" "	182	7	189	252
36	O K. Mammoth Prolific	" "	Aug. 7,		" 29,	176½	20	196½	262
37	White Elephant	" "	July 23,		" "	195	12½	207½	276⅔
38	Red Elephant	" "	" 16,		" "	184	11½	195½	260⅔
39	Jumbo	" "	Aug. 6,		" "	152½	23	175½	234
40	White Seedling	" "	July 21,		" "	189½	12	201½	268⅔
41	Monroe County Prize	" "	" 23,		" "	201	6	205	272⅓
42	Rose's New Giant	" 26,	" 23,		" "	196½	7	203½	271⅓
43	Rose's Beauty of Beauties	" "	Aug. 1,		" "	127½	22	147½	196⅔
44	Early Goodrich	" "	July 20,		" "	167	7	174	232
45	Jackson White	" "	Aug. 1,		" "	202	8	210	280
46	Morning Star	" "	July 20,		" "	164	7	171	228
47	Delaware	" "	" 17,		" "	223	12	235	313⅓
48	*Stray Beauty	" "	–		" "	51	1	56	
49	*Bonanza	" "	July 25,		" "	19½	1	20½	
50	*New Wide Awake	" "	–		" "	10	1½	11½	
51	*Windsor's No. 1	" "	July 25,		" "	11	2	13	
52	*John Emerson's Seedling	June 6,	Aug. 1,		" "	4	½	4½	

*Of the Stray Beauty, only 35 hills were planted; of the Bonanza, 14 hills; of the new Wide Awake, 23 hills; of Windsor's No. 1, 16 hills; of John Emerson's Seedling, 5 hills.

OATS.

Report of Trials for 1887.

Each variety of oats was sown broadcast on a fortieth acre plot, two quarts of seed to each plot. The seed was sown May 17th, on much the same kind of soil, manured in the same way, as in the case of the potatoes. In the next table can be seen a record of the

(1) Date when the heads first began to show.

(2) Date of cutting, which indicates date of ripening.

(3) Yield of each variety per plot and per acre.

(4) Weight of a measured bushel of each variety. It is important to notice that a few varieties have a weight per bushel that marks them as being of superior quality. Some of these varieties having different names are undoubtedly the same.

No	Oats—Name of variety.	Heads began to show.	Date of cutting ripe.	Yield per plot.	Yield per acre.	Weight of a measur'd bushel.
				lbs.	bush.	lbs.
1	Triumph.	July 14	Aug. 17	24	32	18
2	Welcome	" 11	" 8	36	48	33
3	White Probestier	" 12	" 15	46½	62	24
4	Mold's Ennobled	" 15	" 17	32½	43.3	21
5	Clydesdale	" 11	" 8	35½	47.3	34
6	Russian White	" 18	" 20	41	54⅔	28
7	Surprise	" 12	" 15	42½	56.6	24½
8	Hopetown	" 22	" 20	19	25⅓	18½
9	Henderson's Clydesdale	" 10	" 8	34½	46	33
10	New Race Horse.	" 11	" 10	35	46.6	34
11	White Belgian	" 11	" 12	34¼	45.6	31½
12	Black Tartarian	" 13	" 17	37¾	50.3	26
13	White Schoener	" 13	" 15	38¼	51	25
14	White Australian	" 12	" 15	41	54.6	26
15	White Victoria	" 11	" 10	35	46.6	32½
16	Harris	" 2	" 1	31½	42	20
17	Hogan	" 11	" 10	34½	46	26
18	Challenge	" 12	" 10	28	37.3	29
19	Wide Awake	" 12	" 15	32	42.6	22
20	Japan	" 15	" 17	29¾	39.6	25½
21	White Contennial	" 20	" 20	17½	23.3	19
22	White Seizure	" 11	" 8	22¾	30.3	33

TRIALS FOR 1888.

The trials for 1888 were made under the same conditions as those for 1887 except as to manuring which was 600 pounds of superphosphate per acre sown broadcast.

Number.	Oats—Variety.	Date of sowing.	Date at which heads commenced to show.	Date of harvesting	Weight of grain in pounds and ounces.	Yield per acre in bushels.	Weight of a measured bushel.
					lbs.		lbs.
1	Triumph	May 23	July 12	Sept. 6	22.00	29.3	28
2	Welcome	" "	" 16	Aug 27	36.00	48.0	36
3	White Probestier	" "	" 19	" "	21.00	28.0	32
4	Mold's Ennobled	" "	" 23	Sept. 6	22.50	30.0	32
5	Clydesdale	" "	" 16	Aug 27	19 00	25.3	34
6	Russian White	" "	" 17	Sept. 6	28.75	38.3	34.5
7	Surprise	" "	" 17	Aug. 28	59.50	79.3	33
8	Hopetown	" "	" 23	Sept. 6	37.00	49.3	33.5
9	Henderson's Clydesdale	" "	" 16	Aug. 23	44.50	59 3	38
10	New Race Horse	" "	" 16	" "	43.00	57.3	36.5
11	White Belgian	" "	" 17	" "	39.00	52.0	37
12	Black Tartarian	" "	" 19	Sept. 6	51.00	68.0	31
13	White Schoener	" "	" "	" 3	51.75	69 0	32.5
14	White Australian	" "	" "	" "	39.50	52.6	32
15	White Victoria	" "	" 16	Aug. 23	30.75	41.0	37
16	Harris	" "	" 10	" "	30.50	40.6	25.5
17	Hogan	" "	" 17	" "	41.25	55.0	30
18	Challenge	" "	" 16	" "	40.00	53.3	35
19	Wide Awake	" "	" 17	Sept. 3	53.50	71.3	31.5
20	Japan	" "	" 19	" 6	44.50	56 0	34
21	White Centennial	" "	" 25	" 13	20.00	26.6	28
22	Seizure	" "	" 16	Aug. 25	43.75	58.3	36

The light weight and small yield of the triumph, Harris, white centennial place them among the worthless varieties.

BARLEY.

REPORT OF TRIALS FOR 1887.

The plots on which the barley was sown were of the same size, and were treated in the same way as the oat plots. The same observations were made, also in regard to the growth and yield.

No.	Barley. Name of Variety.	Heads began to show.	Date of Cutting Ripe.	Yield per Plot.	Yield per Acre.	Weight of a Measured Bushel.
				lbs.	bush	lbs.
1	Imperial	July 4	Aug 2	23	17.1	38
2	Menshury	" 4	" 2	20	16.7	36
3	Chevalier	" 12	" 10	23½	19.6	37
4	Nepaul	" 3	" 1	36	32.5	49
5	Melon Barley	" 12	" 10	22½	18.8	37
6	Purple Hulless	" 2	" 1	29¾	24.6	53
7	Champion Two-Rowed	" 5	" 8	41¾	34.8	43

REPORT OF TRIALS FOR 1888.

The barley trials for 1888 were made under the same conditions as to size of plots, manuring, etc., as the oat trials for that year.

Number.	Barley—Variety.	Date of sowing.	Date at which heads commenced to show.	Date of harvesting.	Weight of grain in pounds.	Yield per acre in bushels by weight.	Weight per measured bushel.
1	Imperial..................	May 23,	July 12,	Aug. 25,	25.00	20.8	36.0
2	Mensury................	"	" 10,	"	39.75	33.1	36.0
3	Chevalier................	"	" 13,	Sept. 3,	60.50	50.4	39.0
4	Nepaul..................	"	" 13,	Aug. 28,	38.00	31.2	49.0
5	Melon....................	"	" 17,	Sept. 3,	41.00	34.2	41.0
6	Purple Hullers..........	"	" 10,	Aug. 28,	28.00	25.0	53.5
7	Champion Two Rowed....	"	" 9,	"	56.50	46.7	41.5

Attention is called to the fact that only two of the varieties of barley are up to the standard weight of 48 pounds per bushel.

PEAS.

REPORT OF TRIAL FOR 1887.

The soil on which the peas were planted was similar to that used for the varieties of potatoes and grains and it was manured in the same way.

Each variety occupied a row forty feet long, the rows being three and one-half feet apart. The seed was sown so as to secure about the same number of plants in each row, consequently as the peas differed much in size the amount of seed used varied greatly with the different varieties. The length of time required to produce marketable peas, productiveness and quality are the main considerations in studying varieties of peas. It was not possible to test the quality for table use of all of these varieties, but information on the other two points is obtained by noticing the

(1) Date of first blossoms and at which some pods were ready for the market, and

(2) The weight of dry peas produced. (The dry peas were weighed in March, 1888). The color, size and shape of the different peas are in general a fairly good test of quality, the small, smooth, white varieties being as a rule, least palatable, and the large, wrinkled, green varieties, most so.

No.	Peas—Name of Variety.	Date of planting.	First blossoms seen	Some Peas large enough for market.	Vines pulled ripe.	Yield of dry Peas.	escription.
						lbs. oz	
1	King of the Dwarfs	May 19	June 24	July 11	Aug. 1	4 5	Medium, green, wrinkled.
2	Wm. Hurst	"	" 30	" 18	" 10	2 14	Small, white, nearly smooth.
3	American Wonder	"	" 24	" 8	" 1	3-15	Medium, green, wrinkled
4	Earliest of All	"	" 22	" 7	" 1	4 13	Small, green, nearly smooth.
5	Minimum	"	" 25	" 9	" 1	2-2	Small, whi e, wrinkled.
6	Improved Tom Thumb	"	" 24	" 8	" 1	3-8	Medium, white, nearly smooth
7	McLean's Little Gem	"	" 27	" 11	" 8	4-12	Medium, green, wrinkled.
8	McLean's Blue Peter	"	" 25	" 9	" 1	3-7	Medium, green, nearly smooth.
9	Henderson's First of All	"	" 24	" 8	" 1	4-4	Small, white, smooth.
10	Dominion	"	" 24	" 8	" 1	4-4	Small, green, nearly smooth.
11	Day's Early Sunrise	"	" 28	" 18	" 16	5 11	Large, white, wrinkled.
12	Laxton's Prolific Long Pod	"	July 14	" 20	" 16	6-2	
13	Alaska	"	June 21	" 7	" 1	3-10	Small, green, smooth.
14	Delicious	"	July 4	" 26	" 20	3-4	Large, green, wrinkled.
15	Bliss' Abundance	"	June 30	" 19	" 16	5-0	Large, green, wrinkled.
16	Bliss' Ever-Bearing	"	July 5	" 21	" 19	4 12	Large, green, wrinkled.
17	Horsford's Market Garden	"	June 30	" 19	" 19	4-0	Medium, green, wrinkled.
18	Dwarf Champion	"	July 5	" 23	" 19	5-2	Large, green, wrinkled.
19	Maud S.	"	June 24	" 8	" 1	3 8	Small, white smooth.
20	John Bull	"	July 5	" 23	" 29	4-0	Large, green, wrinkled.
21	Carter's Pride of the Market	"	" 6	" 22	" 20	4-5	Large, green, some wrinkled.
22	Hancock	"	June 24	" 8	" 1	3-6	Small, white, smooth.
23	Fill-Basket	"	July 5	" 21	" 16	7-1	Medium, green, somewhat wrinkled.
24	Kentish Invicta	"	June 24	" 8	" 1	3 4	Small, green, nearly smooth.
25	Laxton's Alpha	"	" 24	" 11	" 8	2 4	Small, green, wrinkled.
26	McLean's Advancer	"	" 27	" 13	" 8	3 10	Medium, green, wrinkled.
27	Hair's Dwarf Mammoth	"	July 6	" 23	" 29	3-14	Large, green, wrinkled.
28	Brown's Dwarf Marrowfat	"	" 4	" 20	" 20	5-	Medium, white, smooth.
29	Yorkshire Hero	"	June 28	" 20	" 19	3-18	Large, green, wrinkled.
30	Carter's Stratagem	"	July 6	" 22	" 20	4-11	Large, green, wrinkled.

31	Eugenio	"	June 28	" 20	" 19	4-10	Large, white, wrinkled.
32	Prince of Wales	"	July 4	" 21	" 19	4-15	Large, white, wrinkled.
33	Walker's Perpetual-Bearing	"	" 13	Aug. 1	Sept. 10	2-8	Large, white, wrinkled.
34	Tall Butter Sugar	"	" 1	July 19	Aug. 29	3-	Medium, white, smooth.
35	Telegraph	"	" 4	" 20	" 16	5-0	Large, green, somewhat wrinkled.
36	Laxton's Superlative	"	" 5	" 22	" 16	6-12	Medium, green, somewhat wrinkled.
37	Dwarf Sugar	"	June 30	" 18	" 8	4-8	Very small, white, smooth.
38	Champion of England	"	July 6	" 26	" 19	5-0	Large, green, wrinkled.
39	Black-Eyed Marrowfat	"	" 11	" 26	" 20	7-15	Large, white, smooth.
40	Large White Marrowfat	"	" 11	" 26	" 29	7-6	Large, white, smooth.
41	Telephone	"	" 5	" 20	" 29	4-15	Large, green, wrinkled.
42	Blue Imperial	"	" 6	" 25	" 29	7-1	Large, green, slightly wrinkled.
43	Forty-Fold	"	" 4	" 20	" 29	5-9	Large, green, wrinkled.
44	Vetches Perfection	"	" 6	" 23	" 29	5-2	Large, green, wrinkled.
45	Laxton's Marvel	"	" 7	" 26	" 29	5 9	Large, white, wrinkled.
46	British Queen	"	" 12	Aug. 1	Sept. 10	3-10	Large, white, wrinkled.
47	Bishop's Dwarf	"	" 6	July 23	Aug. 20	7-5	Small, white, smooth.
48	Bishop's Long Pod	"	" 6	" 22	" 20	7-0	Large, white, smooth.
49	French Canner	"	June 30	" 20	" 16	7-10	Small, white, smooth.
50	Early Frame	"	" 24	" 8	" 1	4-0	Small, white, smooth.

Report of Trials for 1888.

The soil on which the peas were planted in 1888 was similar to that on which they were grown the year before. The manuring was like that for the potatoes, oats and barley for the same year.

The peas were planted in rows three feet apart and forty feet long. Each variety occupied a single row.

No.	Peas. Variety.	Date of Planting.	Date of Blossoming.	Date at which Peas were ready for market	Date of harvesting.	Weight of Dry Shelled Peas.	Description.
						lbs. oz.	
1	King of the Dwarfs	May 24	June 27	July 19	Sept. 6	3 - 9	Medium, green, wrinkled.
2	William Hurst	"	July 4	" 25	"	3 - 14	Small, white, nearly smooth.
3	American Wonder	"	June 27	" 16	Aug. 29	3 - 0	Medium, green, wrinkled.
4	Earliest of All	"	June 26	" 14	"	5 - 11	Small, green, nearly smooth.
5	Minimum	"	"	" 14	"	3 - 0	Small, white, wrinkled.
6	Improved Tom Thumb	"	"	" 14	"	3 10	Medium, white, nearly smooth.
7	McLean's Little Gem	"	"	" 14	"	5 - 1	Medium, green, wrinkled.
8	McLean's Blue Peter	"	"	" 13	Aug 20	3 3	Medium, green, nearly smooth.
9	Henderson's First of All	"	"	" 13	"	3 - 12	Small, white, smooth.
10	Dominion	"	"	" 13	Aug. 29	4 - 11	Small, green, nearly smooth.
11	Day's Early Sunrise	"	July 2	" 21	Sept 6	5 - 12	Large, white, smooth.
12	Laxton's Prolific Long Pod	"	" 7	" 30	"	6 - 8	– – – –
13	Alaska	"	June 25	" 11	Aug. 20	3 - 13	Small, green, smooth.
14	Delicious	"	July 10	Aug. 1	Sept. 14	5 - 0	Large, green, wrinkled.
15	Bliss' Abundance	"	" 5	July 25	" 14	4 - 8	" "
16	Bliss' Ever Bearing	"	" 13	Aug. 1	" 14	4 - 12	" "
17	Horsford's Market Garden	"	" 5	July 27	" 6	5 - 6	Medium, green, wrinkled.
18	Dwarf Champion	"	" 12	Aug 1	" 14	4 - 7	Large, green, wrinkled.
19	Maud S.	"	June 26	July 13	Aug. 20	2 - 12	Small, white, smooth.
20	John Bull	"	July 15	Aug. 1	Sept. 14	3 - 14	Large, green, wrinkled.
21	Carter's Pride of the Market	"	"	"	"	2 - 12	Large, green, some wrinkled.
22	Hancock	"	June 26	July 13	Aug. 20	2 13	Small, white, smooth.
23	Fill Basket	"	July 12	Aug. 1	Sept. 6	5 11	Medium, green, some wrinkled.
24	Kentish Invicta	"	June 26	July 13	Aug 29	4 - 4	Small, green, nearly smooth.
25	Luxton's Alpha	"	"	" 16	"	3 - 3	Small, green, wrinkled.
26	McLean's Advance	"	July 3	" 21	"	4 - 2	Medium, green, wrinkled.
27	Hair's Dwarf Mammoth	"	" 9	" 30	Sept. 14	3 - 12	Large, green, wrinkled.
28	Brown's Dwarf Marrowfat	"	" 9	" 30	"	4 12	Medium, white, smooth.
29	Yorkshire Hero	"	" 10	" 31	"	2 - 14	Large, green, wrinkled.

No.	Peas. Variety.	Date of Planting.	Date of Blossoming.	Date at which Peas were ready for market.	Date of harvesting.	Weight of Dry Shelled Peas. lbs. oz.	Description.
30	Carter's Strategem	May 24	July 12	Aug. 1	Sept. 14	3- 3	Large, green, wrinkled.
31	Eugenie	"	June 30	July 21	"	4-12	" "
32	Prince of Wales	"	July 9	" 30	Sept. 6	5- 0	Large, white, wrinkled.
33	Walker's Perpetual Bearing	"	" 20	Aug. 14	" 24	3 1	" "
34	Tall Butter Sugar	"	" 4	July 25	" 14	3-10	Medium, white, smooth.
35	Telegraph	"	" 9	" 30	" 14	4- 2	Large, green, some wrinkled.
36	Laxton's Superlative	"	" 10	" 31	" 6	6-12	Medium, green, some wrinkled.
37	Dwarf Sugar	"	" 2	" 21	" 6	5- 3	Very small, white, smooth.
38	Champion	"	" 13	Aug. 1	" 14	4-10	Large, green, wrinkled.
39	Black Eyed Marrowfat	"	" 16	" 3	" 14	5-13	Large, white, smooth.
40	Large Marrowfat	"	" 16	" 3	" 4	5- 6	" "
41	Telephone	"	" 13	" 1	" 14	3- 7	Large, green, wrinkled.
42	Blue Imperial	"	" 9	July 30	" 14	4-11	Large, green, slightly wrinkled.
43	Forty Fold	"	" 9	"	" 14	6- 1	Large, green, wrinkled.
44	Vetches' Perfection	"	" 12	Aug. 1	" 14	3-13	" "
45	Laxton's Marvel	"	" 13	"	" 14	4- 1	Large, white, wrinkled.
46	British Queen	"	" 19	Aug. 6	" 24	5- 0	" "
47	Bishop's Dwarf	"	" 12	" 1	" 14	4-15	Small, white, smooth.
48	Bishop's Long Pod	"	" 12	" 1	" 6	5- 7	Large, white, smooth.
49	French Canner	"	" 13	" 1	" 6	6- 0	Small, white, smooth.
50	Early Frame	"	June 26	July 13	Aug. 20	3- 8	" "
51	*Prize Taker	"	July 13	Aug. 2	Sept. 14	5-10	Large, green, somewhat wrinkled.
52	*Rural New Yorker	"	June 26	July 13	Aug. 29	3- 2	Small, white, smooth.
53	*Emerald Gem	"	July 4	" 21	Sept. 24	0-12	Small, green, wrinkled.

*Numbers 51, 52 and 53 were from the U. S. Department of Agriculture. Only a portion of 53 germinated.

EXPERIMENTS IN IMPROVEMENT OF PLANTS BY SEED SELECTION.

The idea prevails to a considerable extent that great improvement may be made in the productiveness of agricultural plants by the careful selection of the largest, plumpest seeds for planting. With a view of learning to what extent if any, such improvements could be brought about the following experiment was undertaken. Four varieties of oats were taken from which were selected the largest, heaviest kernels to the amount of two quarts in each case. These were sown on plots of land 12 feet by 90 feet while like amounts of the same varieties of oats which were taken from the common stock were sown on similar adjoining plots. Both sets of plots received the same treatment as to cultivation and manure.

In the following table the results are given :

Oats—Variety.	Yield of grain when largest and heaviest kernels selected for seed.		Yield of grain from seed from the common stock.		Weight of measured bushel from selected seed.	Weight for measured bushel from common seed.
	lbs.	oz.	lbs.	oz.	lbs.	lbs.
Clydesdale	38	0	19	0*	34	34
New Race Horse....................	42	8	43	0	36	36.5
White Victoria......................	42	4	30	12	35	37
White Seizure...........	44	12	43	12	32	36

*The Clydesdale plot sown to the common seed was invested with witch grass and the yield much depressed.

During the growing season many who visited the plots believed those which were planted with the selected seed, to have stronger and more vigorous plants. An examination of the results show no increase in the weight of a measured bushel of the oats from the selected seed over those grown from the common stock, and it is very doubtful if any actual gain has been made in the yield per plot.

REPORT OF BOTANIST AND ENTOMOLOGIST.

Prof. F. L. Harvey.

GERMINATION EXPERIMENTS.

It is well known that seeds often fail to germinate, causing great loss to the planter. To what extent poor seed is offered for sale in this state is not known. Farmers do not usually take the trouble to sprout seed before planting. The germinating power of seed cannot readily be told by its appearance, and there is opportunity for dishonest dealers to mix old seed with fresh, and sell an inferior quality, without danger of being detected. Reliable dealers may sell a poor quality of seed without knowing it. If the quality of seed offered for sale in our markets could be improved, it would be a great saving to farmers. Published accounts of the germinating power of seeds offered for sale by seedsmen will make them more careful of the quality of seed sold, and also help protect reliable dealers from disreputable ones.

Failure to germinate may be due to imperfections in the seed, or result from improper management of it by the planter.

Seed, to be reliable, should be mature and plump when gathered; properly dried and kept from changing conditions of heat, cold and moisture until planted; should not be too old; true to name; entirely free from insect depredations and the seeds of noxious weeds. When possible, select seed from the same or from a more northern latitude. Lightness in weight indicates immaturity or weakness. Low germinating power may be due to immaturity or weakness, improper care of seed after it is gathered, or to great age. Insect depredations and the presence of foreign seeds can usually be detected by a pocket lens. To determine whether a seed is true to name it has to be grown, or, more quickly, it may be compared with a correctly named sample.

To properly germinate, seeds require heat, moisture and free access of air. The relative amount differs with different seeds.

Proper time, depth and method of planting; and the conditions of soil as regards heat, moisture and porosity, are almost as important to the planter as good seed.

Seeds with a small chit or embryo start slowly and suffer more from vicissitudes than those with a large, strong embryo. In general, small seeds demand shallow planting and larger ones more depth of soil. Nothing is gained by planting before the soil is warm enough or properly drained, but the seed is frequently lost. Seeds buried in a cold, moist soil any length of time are liable to rot. The soil should be dry enough to work, porous, allowing access of air to the seed. Seeds planted early should be more lightly covered, so as to secure necessary warmth.

So complex and variable are the conditions due to the season, soil and seed, that no invariable rules for planting can be formulated. The planter has largely to rely upon his experience and judgment, even when his seed is first class.

To remove or lessen one cause of failure would require more careful farming. The other cause of failure can be lessened by a careful, systematic inspection of seeds. To determine to what extent the failure of seeds to germinate is due to inferior quality, the station will conduct germination tests from year to year; and, as was indicated in bulletin No. 24, May, 1888, inspect seeds sent by the farmers of the state as to their purity and germinating power.

For the germination tests conducted this season, there were selected for examination and comparison, seeds offered for sale by wholesale dealers in the state; those kept at stores to be sold on commission; those obtained direct from wholesale houses outside the state, and those distributed by the Department of Agriculture.

The material for this season's work was obtained from the following sources: Edwin Chick & Co., Bangor, Me., direct; R. B. Dunning & Co., Bangor, Me., direct; Kendall & Whitney, Portland, Me., direct; B. Walker McKeen, Fryeburg, Me., direct; E. W. Burbank, Fryeburg, Me., direct; Thos. W. Emerson & Co., Boston, Mass., Dunning, Bangor; D. M. Ferry & Co., Detroit, Mich., direct; David Landreth & Sons, Philadelphia, Pa., direct; James M. Thorburg & Co., New York, N. Y., direct; Iowa Seed Co., Des Moines, Iowa, Department of Agriculture; Department of Agriculture, Washington D. C., direct.

GERMINATORS.

The germinator used was a galvanized tray eight inches deep, covered with a dome shaped lid. On the inside of the tray, on two sides, and one inch from the top, were soldered waving shelves, in the groves of which rods to support pockets or folds of canton flannel cloth were placed.

Near the top of the tray, above the shelves, was a row of one half inch holes for admitting fresh air. Water to the depth of two inches was placed in the tray. The pockets were provided with two free ends of cloth which extended below into the water, carrying moisture to the seed by capillary attraction. The pockets were three inch deep and two inches from the water. The greater depth of water in the tray, than is commonly used, secured a more uniform temperature. Very small seeds were germinated in porous flower pot saucers, set in water in the bottom of the tray, deep enough to keep them moist. To sterilize the trays and pockets they were scalded after each experiment. *The above apparatus was satisfactory.*

In all the tests *one hundred* seeds were used. They were counted and weighed, and then put into the pockets without being soaked and spread so as not to touch each other. They were examined daily and those sprouted were removed, counted and recorded. The experiments were continued two weeks, if any sound seeds remained that length of time unsprouted, and then the sound seeds left were counted.

The following tables are a record of the results of experiments conducted the past season. Seeds of the same kind are grouped together for the purposes of comparison.

It is well known that with the uniform conditions maintained in germination tests that usually a larger per cent of seeds will sprout, than would vegetate under the variable conditions of out door planting. Yet it does not follow that the testing of seeds is useless

Seed showing a high germination per cent would almost invariably be reliable for planting, while those that do not start with favorable conditions would be worthless.

RESULTS OF GERMINATION TESTS—GARDEN SEEDS.

Serial number.	Station number.	Description.	Weight of 100 seeds in grams.	Per cent. of impurities by weight.	Number of seeds sprouted each day.														Sound seeds left.	Per cent. sprouted.	No. of days required for one-half to sprout.
					1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th			
		Lettuce.																			
1	1	Early White Cabbage, Chick	.141	1	–	–	99	–	–	–	–	–	–	–	–	–	–	–	–	99	3
2	14	Boston Curled, Dunning	.087	1	–	–	64	–	10	2	–	1	–	–	–	–	–	–	22	77	3
3	38	" " Emerson	.096	–	–	–	–	10	–	–	–	–	–	–	–	–	–	–	90	10	
4	47	Ferry's Early Prize, Ferry	.137	–	–	–	95	–	–	1	–	1	–	1	–	–	–	–	–	98	3
5	163	White Chavigne, Dep't Agriculture	.120	–	–	33	34	14	5	–	–	–	–	–	–	–	–	–	–	86	3
6	164	White Paragon, " "	.146	–	68	25	–	1		–	–	–	–	–	–	–	–	–	–	94	1
		Turnip.																			
7	2	Skirving's Ruta Baga, Chick	.242	–	–	–	51	5	7	3	5	4	–	1	–	–	–	–	9	76	3
8	17	Ruta Baga, Dunning	.329	–	–	–	–	5	6	5	5	2	3	1	1	1	–	–	45	29	
9	37	" " Emerson	.256	–	–	–	94	0	3		–	–	–	–	–	–	–	–	3	97	3
10	46	" " Ferry	.275	–	–	–	56	4	3	4	2	–	–	–	–	–	1	1	22	71	3
		Cabbage.																			
11	3	Fottler's Improved Brunswick, Chick	.331	–	–	–	60	–	3	2	3	1	–	–	–	–	–	–	6	69	3
12	16	Drumhead, Dunning	.326	–	–	–	75	5	3	–	2	1	–	–	–	–	–	2	6	88	3
13	36	Fottler's Improved Brunswick, Emerson	.331	–	–	–	83	–	4	–	–	3	1	–	–	–	–	1	3	92	3
14	42	Large Drumhead, Ferry	.346	–	–	–	66	3	2	1	–	–	–	–	–	–	1		2	73	3
15	155	Extra Early Pointed Market, Dep't Agr.	.387		–	42	29	2	3	1	–	–	1	–	–	–	1	–	20	79	3
16	156	Buncome, Dep't Agr	.325	–	20	54	8	3	–	–	–	–	–	–	–	–	1	–	3	86	2
17	157	Berkshire Beauty, Dep't Agr	.435	–	–	56	26	7	3	2	–	–	1	–	–	–	–	–	1	95	2
18	158	Stone Mason, Dep't Agr	.320	–	–	16	9	2	16	7	4	1	2	–	–	–	–	1	38	61	6

RESULTS OF GERMINATION TESTS—GARDEN SEEDS.—(Continued).

Serial number.	Station number.	Description.	Weight of 100 seeds in grams.	Per cent. of impurities by weight.	Nnmber of seeds sprouted each day. 1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	Sound seeds left.	Per cent. sprouted.	No. of days required for one-half to sprout.
		Parsnip.																			
19	4	Long Smooth, Chick	.438	1	-	-	.	10	-	23	3	-	5	-	3	-	-	-	50	44	
20	18	Long Dutch, Dunning	.421	-	-		-	-	1	3	5	3	4	7	4	3	4	-	58	34	
21	39	Hollow Crown, Emerson	.376	-	-	-	-	-	7	10	7	6	8	4	4	-	1	2	41	49	
22	45	Long White Dutch, Ferry	.400	-	-	-	-	-	7	10	14	26	5	3	3	2	-	-	26	70	8
		Celery.																			
23	5	Boston Market, Chick	.035	-	-	-	-	-	-	-	3	3	-	4	4	5	6	2	70	27	
24	19	" " Dunning	.047	-	-	-	.	-	-	3	4	6	-	21	7	10	8	3	36	62	12
25	44	" " Ferry	.042	-	-	-	-	-	-	4	6	10	13	7	5	-	2	1	47	48	
		Onion.																			
26	6	Yellow Danvers, Chick	.390	-	-	48	19	3	2	1	1	-	-	-	-	-	-	-	20	74	
27	12	" " Dunning	.370	-	-	20	27	9	3	1	.	2	-	-	-	-	-	-	25	62	4
28	35	" " Emerson	.344	-	-	33	37	17	3	3	2	-	-	-	-	-	-	-	-	95	3
29	43	" " Ferry	.412		-	17	30	8	4	3	1	3	1	-	-	-	-	-	25	67	4
		Beet.																			
30	7	Dewing's Early Turnip, Chick	1.937	-	-	3	32	14	2	2	2	3	2	-	1	1	1	-	35	63	5
31	13	" " " Dunning	1.633	-	-	-	-	1	3	2	4	1	3	2	1	1	-	-	82	18	
32	34	" " " Emerson	2.230	-	-	7	38	18	5	4	2	2	1	-	-	-	-	-	20	77	4
33	40	Early Blood " Ferry	2.022	-	-	1	41	24	3	3	2	2	-	-	-	-	-	-	22	76	4

34	149	New Market Gardner's, Iowa Seed Co........	2.468	–	–	1	12	22	18	–	–	–	–	–	–	2	–	–	40	60	5
35	150	Osborn's Selected, Dep't Agr...............	1.560	–	–	3	52	16	12	2	–	1	–	–	–	–	1	–	13	87	3
36	151	Eclipse, Dep't Agr......................	1.282	–	–	2	11	22	9	5	2	3	1	2	1	1	–	–	41	59	7
37	145	Lane's Imperial Sugar, Dep't Agr.........	2.226	–	–	–	–	14	18	5	4	1	2	–	1	–	1	–	54	46	
38	146	Improved Imperial Sugar, Dep't Agr.... ..	2.618	–	–	–	26	19	12	4	5	–	–	1	1	1	1	–	30	70	5
39	147	Vilimorin's Sugar, Dep't Agr	2.430	–	–	–	45	34	14	–	–	–	–	1	–	–	–	–	6	94	
40	148	Excelsior " " "	2.093	–	–	–	2	14	15	6	3	1	–	–	–	–	–	–	59	41	4
		CARROT.																			
41	15	Long Orange, Dunning	.125	2	–	–	4	7	17	19	1	2	–	1	–	–	–	–	23	51	8
42	33	Prize Long Orange, Emerson.............	.150	–	–	–	3	28	14	2	1	–		–	–	–	–	–	50	48	
43	41	Improved Long Orange, Ferry..	.110	–	–	–	14	16	13	6	1	5	1	2	1	1	–	–	25	60	7
		TOMATO.																			
44	159	Reed's Island Beauty. Dep't Agr..........	.310	–	–	2	52	27	9	1	–	–		1	–	–	–	1	1	93	3
45	160	Beauty, Dept Agr.............	.326	–	2	26	50	9	2	–	–	2	–	–	–	–	–	–	4	91	3
46	161	Early Advance, Dep't Agr................	.278	–	–	1		3	6	3	4	1	1	–	1	–	–	–	80	20	
47	162	Boston Market, Dep't Agr............	.286	–	–	–	2	5	7	3	5	–	3	1	2	–	–	–	72	28	
		SWEET CORN.																			
48	48	Common. B. W. McKeon..................	18.920	–	–	–	10	42	20	17	1	–	–	–	–	–	–	–	–	90	4
49	152	Perry's Hybird, Dep't Agr................	24.200	–	–		4	25	28	23	2	1	–	–	–	–	–	–	–	83	5
50	153	Brock's Perrennial, Dep't Agr..	23.578	–	–	–	11	27	25	10	2	6	1	–	–	–	–	–	–	82	5
51	154	Burbank's Improved, E. W. Burbank.......	28.084	–	–	–	0	11	30	42	12	3	–	–	–	–	1	–	–	99	6
		LEGUMES—CLOVER.																			
52	8	Common Red, *Trifolium pratense*, Chick......	.164	–	–	–	92	–	–	–	–	–		–	–	1	–	–	7	93	3
53	25	Pea Vine, " Dunning...	.154	–	–	–	97	–	–	–	–	–	–	–	–	–	–	–	2	97	3
54	27	Primo Medum, " " ..	.166	–	–	–	96	–	–	–	–	–	–	–	–	–	–	–	3	96	3
55	88	Common Red, " Thorburn..	.148	–	70	13	3	–	–	–	–	–	1	–	–	–	–		11	87	1
56	91	Pea Vine, " " ..	.160	–	48	39	3	1	–	–	–	–	–	–	–	–	–	–	5	91	2
57	113	" " Kend. & Whit.,	.16[illegible]	–	53	36	4	1		–	–	–	[illegible]	–	–	–	–	–	–	94	1
58	114	North New York, " "	.160	–	64	27	1	–	–	–	–	–	–	–	–	–	–	–	3	92	1
59	115	Michigan, " "	.157	–	27	52	2	–	–	–	–	–	–	–	–	–	–	–	–	81	2
60	11	Alsike, *Trifolium pratense, hybridum*, Chick...	.060	–	2	39	26	12	2	2	–	–	2	–	2	–	1	–	4	88	3
61	24	" " " Dunning	.068	–	1	11	10	8	10	14	6	5	3	1	3	–	–	–	8	72	6
62	86	" " " Thorburn	.066	–	57	11	–	–	1	–	–	–	–	–	–	–	–	–	31	69	1
63	116	" " " Kend. & Whit	.068	–	22	30	4	5	5	1	–	–	–	–	1	–	1	–	23	69	2
64	125	" " " Landreth	.070	–	36	26	6	7	2	1	–	–	–	–	–	–	–	–	15	78	2

RESULTS OF GERMINATION TESTS—GARDEN SEEDS.—(CONTINUED).

Serial number.	Station number.	Description.	Weight of 100 seeds in grains.	Per cent. of impurities by weight.	No. of seeds sprouted each day. 1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	Sound seeds left.	Per cent. sprouted.	No. of days required for one-half to sprout.
		LEGUMES—CLOVER.																				
65	10	White, *Trifolium pratense, repens*, Chick..	.057	–	–	3	15	26	7	15	7	2	3	–	–	–	–	–	18	78	4
66	26	" " " Dunning...	.054	–	–	–	85	–	1	–	1	–	–	–	–	–	–	–	8	87	3
67	92	" " " Thorburn..	.060	–	55	27	3	–	–	–	–	–	–	–	–	–	–	–	13	85	1
68	117	" " " K. & W...	.065	–	27	48	4	2	1	1	–	–	–	–	–	–	–	–	13	83	2
69	97	Incarnate, " *incarnatum*, Thorburn ..	.368	–	95	5	–	–	–	–	–	–	–	–	–	–	–	–	–	100	1
		LEGUMES.																				
70	95	Yellow Trefoil, Thorburn ..	.175	–	41	40	3	–	1	–	–	–	–	–	–	–	–	–	–	85	2
71	124	" " Landreth ..	.173	–	12	59	7	5	–	–	–	–	–	–	–	–	–	–	–	83	2
72	94	Alfalfa or Lucerne, *Medicago sativa*, Thorburn	.220	–	21	34	6	1	–	–	–	–	1	–	–	1	1	–	36	65	2
73	118	" " Landreth	.226	–	40	49	2	1	–	–	–	1	–	–	–	–	–	–	3	93	2
74	87	Bakhara or S Clover, *Melilotus alba*, Thorburn	. 56	–	33	6	2	27	–	–	–	–	–	–	–	1	–	–	25	69	4
75	89	Bush Clover, *Lespedeza striata*, Thorburn.....	.103	–	–	3	8	35	20	5	–	1	–	–	1	–	–	–	20	73	5
76	85	Furze, *Ulex Europeaeus*, Thorburn	.668	–	92	1	–	0	–	–	–	–	–	–	–	–	–	–	2	93	1
77	90	Cow Peas, *Dolichos sinensis*, Thorburn	19.890	–	–	12	30	45	9	4	–	–	–	–	–	–	–	–	–	100	4
78	93	Sainfoin, *Onobrychis sativa*, Thorburn ...	1.963	–	–	0	7	15	4	11	12	8	7	3	2	1	–	–	6	70	7
79	119	" " Landreth........	2.064	–	–	0	2	10	14	7	14	6	3	5	–	2	1	–	19	64	8
		MISCELLANEOUS.																				
80	82	*Madia sativa*, Thorburn............	.732	–	1	88	7	–	–	–	–		–	–	–	–	–	–	–	97	1
81	96	Spurrey, *Spergula arvensis*, Thorburn	.091	–	–	26	9	8	5	1	2	2	1	–	2	–	1	–	24	57	7

		GRASSES—MILLET.																			
82	22	Golden, *Panicum miliaceum*, Dunning.......	.010	-	-	-	85	-	1	-	-	-	-	-	-	-	-	-	2	87	
83	110	" " Kend. & Whit...	.232	-	4	54	30	3	-	-		-	-	-	-	-	-	-	8	91	3
84	122	Southern, Landreth......	.190	-	4	86	2	-	-	-	-	-	-	-	-	-	-	-	-	92	2
85	81	Pearl, Thorburn.....	.560	-	10	50	3	-	2	-	-	-	-	-	-	-	-	-	14	65	2
86	21	Hungarian, *Panicum Germanicum*, Dunning	.223	-	-	-	78	-	2	1	1	-	1		-	-	-	-	5	82	2
87	84	" " Thorburn,	.184	-	-	20	6	-	-	1		-	-	-	-	-	-	-	50	27	3
88	112	" " K. & W.	.181	-	3	53	6	4	-	-	-	1	1	-	-	-	-	-	22	68	2
89	126	" " Landreth,	.212	-	-	64	2	2	-	-	-	-	-	-	-	-	-	-	13	68	2
		GRASSES.																			
90	9	Timothy, *Phleum pratense*, Chick...........	.040	-	-	-	30	50	2	-	-	-	-	-	-	-	-	-	10	88	4
91	20	" " Dunning........	.040	-	-	-	8	24	9	-	-	-	-	1	-	1	-	-	5	95	5
92	66	" " Thorburn........	.040	-	-		25	51	3	-	-	-	-	-	-	-	-	-	10	91	4
93	111	" " Kend. & Whit...	.034	-	-	-	0	7	-	-	-	-	-	-	-	-	-	-	2	96	6
94	23	Fancy Red Top, Dunning.........	.010	-	-	-	10		1	3		3	-	1	-	-	-		20	80	4
95	109	Fancy Red Top, Kend. & Whit....	.009	-	-	-	2	10	14	7	14	6	3	5	-	2	1	-	19	64	8
96	32	Red Top, *Agrostis vulgaris*, Dunning.........	.008	84	-	-	1	7	6	4	-	1	1	-	-	-	-	-	80	20	
97	57	" " " Thorburn........	.010	-	-	-	-	2	12	5	4	1	-	-	1	-		-	75	25	
98	31	Rhode Island Bent, *Agrostis canina*, Dunning.	.009	-	-	-	23	37	7	10	2	1	-	1	-	-	-	-	19	81	4
99	49	" " " " Thorburn	.006	77	-		-	4	12	18	7	8	1	-	1	1	-	-	48	52	9
100	102	" " " " K. & W.	.009	3	-	-	-	-	4	10	16	9	4	-	2	2	-	-	50	47	
101	52	Creeping Bent, *Agrostis stolonifera*, Thorburn	.006	-	-	-	-	4	12	18	7	8	1	-	1	1	-	-	48	52	9
102	30	Fowl Meadow, *Poa serotina*, Dunning.......	.010	70	-	-	-		4	5	1		2	-		-	-	-	88	12	
103	77	" " " Thorburn.......	.010	50	-	-	-		-	1	-		1	1	-	-	-	-	97	3	
104	101	" " " Kend. & Whit..	.014	90	-	-	-	-	-	2	9	11	2	2	9	12	2	1	50	50	14
105	129	" " " Ferry.........	-	90	-	-	-	-	-	1	2	1	1	2	9	13	2	1	68	32	
106	28	Kentucky Blue, *Poa pratensis*, Dunning......	.018	-	-	-	-	-	-	-	1	-	-	3	1	-	-		95	5	
107	68	" " " Thorburn.....	.023	-	-	-	-	-	-	-	-	1	-	5	1	2	2	1	88	12	
108	100	" " " Kend & Whit.	.021	1	-	-	-	-		-	1	2	5	1	4	2	2	-	83	17	
109	70	Wood Meadow, *Poa nemoralis*, Thorburn.	.020	-	-	-	-	1	-	1	2	3	4	1	2	1	0	-	85	15	
110	128	" " " Ferry.......	.018	-	-	-	-	-	-		1	1	2	1	3	3	2	1	86	14	
111	63	Water Meadow, *Poa aquatica*, Thorburn	.024	-	-	-	-	-	-	-	-	-	-	-	-	-		-	100		
112	71	Rough Stalked Meadow, *Poa trivialis*, "	.019	10	-	-	-	3	1	1	1	-		1	4	1	1	-	87	13	
113	75	Canada Blue, *Poa compressa*, "	.020	-		-	-	-	-	1	-	4	1	4	-	-	1	-	89	11	
114	29	Orchard, *Dactylis glomerata*, Dunning	.059	-	-	-	-	-	7	-	9	5	2	6	4		3	2	60	38	
115	69	" " " Thorburn......	.066	-	-	-	-	2	24	10	5	5	6	-	2	-	1	2	40	57	9
116	98	" " " Kend. & Whit..	.075	-	-	-	-	-	15	3	13	5	8	2	-	-	2	2	50	50	14
117	61	Tall Meadow Oat, *Avena elatior*, Thorburn .	.292	-	-	-	2	6	33	4	1	1	-	-	1	-	-	-	50	48	
118	99	" " " " Kend. & Whit	.175	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	98	2	

RESULTS OF GERMINATION TESTS—GARDEN SEEDS.—(CONCLUDED).

Serial number.	Station number	Description.	Weight of 100 seeds in grains.	Per cent. of impurities by weight.	Number of seeds sprouted each day. 1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	Sound seeds left.	Per cent. sprouted.	No. of days required for one-half to sprout.
		GRASSES.																			
119	127	Tall Meadow Oat, *Avena elatior*, Ferry........	.222	–	–	–	9	35	8	6	–	–	–	–	1	–	1	–	40	60	5
120	64	S. Vernal, *Anthoxanthum adoratum*, Thorburn.	.054	–	–	–	–	–	5	4	–	1	1	1	–	1	1	–	80	14	
121	103	" " " K. & W..	.058	–	–	–	–	2	4	6	2	–	1	–	1	2	1	–	80	19	
122	123	" " " Landreth.	.044	–	–	–	–	3	6	2	2	1	–	–	1	–	–	–	85	15	
123	54	Meadow Fescue, *Festuca pratensis*, Thorburn.	.141	–	–	–	–	–	3	4	–	3	–	–	1	1	–	1	87	13	
124	105	" " " K. & W..	.082	–	–	–	–	–	1	2	1	–	–	–	–	2	–	–	90	6	
125	130	" " " Ferry....	.151	1	–	–	–	16	34	12	3	3	3	2	–	–	–	–	20	73	5
126	57	Tall Fescue, *Festuca elatior*, Thorburn.	.099	–	–	–	–	2	12	5	4	1	–	–	1	–	–	–	75	25	
127	107	" " Kend. & Whit.	.174	–	–	–	–	2	7	4	4	–	2	–	–	–	4	2	75	25	
128	55	Various-leaved Fescue, *Festuca heterophylla*, Thorburn	.095	–	–	–		–	–	–	–	–	1	–	–	–	–	2	97	3	
129	56	Sheep's Fescue, *Festuca ovina*, "	.045	–	–	–	–	–	–	3	–	–	–	–	–	–	–	–	97	3	
130	58	Slender Fescue, *Festuca tenuifolia*, "	.022	–	–	–	–	–	9	8	3	2	1	1	1	2	1	2	70	30	
131	74	Hard Fescue, *Festuca duriuscula*, "	.055	–	–	–	–	–	1	1	–	–	–	–	1	–	–	–	90	3	
132	60	Italian Rye, *Solium Italicum*, Thorburn......	.225	–	–	–	52	14	3	22	4	–	–	–	1	–	–	–	2	96	3
133	120	" " Landreth.. ...	.144	–	–	–	5	10	8	4	3	2	–	3	–	–	–	–	65	35	
134	73	Perrennial Rye, *Solium perenne*, Thorburn..	.170	–	–	–	–	12	20	3	3	1	4	–	2	–	–	–	55	45	
135	106	" " Kend & Whit	.165	–	–	–	–	17	9	7	–	1	1	1	–	–	–	–	57	36	
136	121	" " Landreth	.202	–	–	–	30	32	11	3	6	–	–	–	1	–	–	–	10	83	4
137	72	Johnson, *Sorghum halapense*, Thorburn......	.408	–	–	–	–	2	–	–	–	–	–	–		–	–	–	98	2	6
138	131	" " Ferry.........	.242	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–
139	108	Lawn, (mixture) Kend. & Whit ..	.022	2	–	–	–	2	20	53	8	1	–	–	–	–	–	–	15	84	6

140	50	Slender Foxtail, *Alopecurus agrestis*, Thorburn	.212	2	-	-	-	27	11	8	4	2	1	-	-	-	-	-	43	53	7
141	53	Wood Hair, *Aira flemosa*, "	.041	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	99	1	
142	62	Rescue, *Bromus Schraderi*, "	1.002	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	-	
143	65	Meadow Brome, *Bromus pratensis*,	.451	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100	-	
144	79	Soft Chess, " *mollis*	.284	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	57	2	
145	59	Beach, *Ammophila arenaria*, Thorburn........	.396	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	97	3	
146	67	Meadow Soft, *Halcus lanatus*, Thorburn......	.054	5	-	-	-	1	1	12	4	1	-	-	3	-	-	-	74	22	
147	76	Reed Canary, *Phalaris arundinacea*, Thorburn	.062	-	-	-	-	-	4	1	1	-	-	-	-	-	-	-	94	6	
148	78	Crested Dogstail, *Cynosurus cristatus*, "	.634	-	-	-	-	-	-	-	-	4	2	1	2	2	-	-	89	11	
149	80	Teosinte, *Reana luxurians*, Thorburn..........	6.822	-	-	-	3	2	1	2	-	-	-	-	-	-	-	-	92	8	
150	83	Kaffir Corn..............................	2.488	-	-	93	5	-	-	-	-	-	-	-	-	-	-	-	-	98	2

COMPARATIVE RESULTS OF GARDEN SEEDS GERMINATED.

Name.	Chick's seed in bulk.		Dunning's seed in bulk.		Emerson's commission seeds in packets.		Ferry's seeds in packets		Iowa Seed Company's seeds in packets.		Dept Ag— seeds in packets.	
	Varieties tested	Average per cent germinated.	Varieties tested.	Average per cent germinated.	Varieties tested.	Average per cent germinated	Varieties tested.	Average per cent germinated.	Varieties tested.	Average per cent germinated.	Varieties tested.	Average per cent germinated.
Lettuce	1	99	1	77	1	10	1	98	–	–	2	90
Turnip	1	76	1	29	1	97	1	71				
Cabbage	1	69	1	88	1	92	1	73	–	–	4	80
Parsnip	1	44	1	34	1	49	1	70				
Celery	1	27	1	62	1	48						
Onion........	1	74	1	62	1	95	1	67				
Beet.........	1	63	1	18	1	77	1	76	1	60		
Carrot.......	–	–	1	51	1	48	1	60			6	66
Tomato	–	–	–	–	–	–	–		–		4	58

The complaint about commission garden seeds is hardly sustained by our experiments. Emerson's seeds, the only ones tested, make a fair average showing. The lettuce seed was very poor, only ten per cent sprouted. The turnip seed was the best examined and the cabbage and beet seed were excelled only by varieties from the department of agriculture. The onion seeds were superior. The carrot seed was the poorest examined and the tardy germination showed it was old. The freshness of the garden seeds from the department of agriculture is shown by their early germination and good germination per cent.

The garden seeds, Nos. 1 to 51, vary considerably. Farmers and gardners find it difficult to get these kind of seeds to "come up" well. Although at times it may be due to unfavorable conditions of the soil or weather, it is more often due to the seed. If poor seeds are planted, poor results are certain. Beet seed is one of the hardest to sprout. By comparing the beet seed of different dealers, we find the range from 18, to 94, more than five times as many in one case, as in the other, and of greater vitality, as is shown by the number of days of germination. The lowest, No. 31, was given two trials in the germinator, and one in wet sand, 18 per cent being the most sprouted. We found in this case, as well as in others, that the largest seeds gave the best results. Notice the weight of seeds given in the table, and it will generally be found that the heaviest are the best. On the whole the garden seeds show a fair rate of vitality, the exceptions can be easily seen.

By looking in the column marked "Per Cent Sprouted," it will be seen that the range is as wide as is possible, being 100 in the cow-peas, and incarnate or scarlet clover, and 0 in four of the grasses. As the conditions were very nearly the same in each case, it plainly shows the difference in seed. By comparing the grasses one will see that in the more common kinds, for instance Timothy, the per cent germinated is high, 88 to 95, while in those rarely sown it is low. This is easily explained, as seed for which there is but a slight demand, would remain on sale for a long time, so that the greater the demand the newer the seed. This is a good illustration of the differenee between new and old seed, as the per cent sprouted varies from 95 to 0, and from the more common to the less common kinds. The clovers show a high per cent of germination, throughout, some of them sprouting 95 per cent, in twenty-four hours from the time they were put in the germinator. In studying the tables notice the number of days before the seeds began to sprout, as rapid sprouting shows high vitality.

The conclusions we draw from these experiments put into rules to aid in purchasing seed, would be, see that seeds look new and fresh, notice whether they are plump or shriveled, and whether or not they are uniform in size. If some are large and some small, only the former will grow. Also see that they are free from foul seeds, as many troublesome weeds are introduced in this way. Buy of some reliable dealer, and continue to do so as long as the seeds are satisfactory. Buy seeds grown in our own State or from localities as far north. Farmers can easily test seeds, by putting them between damp cloths, or sheets of blotting paper.

Experiments with Forage Plants.

Sixty-six plots were sown last spring with grass seed and the seeds of other forage plants. A report will be made of these experiments another season. The station has started a collection of seeds, and steps are also being taken to form a herbarium of grasses and other forage plants.

POTATO SCAB.

This important disease of the potato has been studied somewhat the past season to determine if possible whether it is due to a fungoid parasite. Quite extended microscopical examination failed to show any evidence of mycelium or spores in the tissues about the scabs, that would account for the effect. The withered tissue in the scabs in some cases was mouldy but this was secondary not primary. The only organic form observed excepting mould was animal, viz: *Nematoid worms*, not unlike the vinegar eel. These were not always present and when found were probably there to feed upon the fermenting starch. The disease is certainly local in the scabs, the adjoining tissue being perfectly normal and not even discolored. The disease is confined to the cortical and sub-cortical cells and has all the appearance of having resulted from mechanical injury, which has ruptured the skin, the wound being healed by the shriveling of the adjacent tissue or the formation of a layer of cork cells under the scabs. Though variable in size the scabs are so characteristic they must be due to a common cause. Extensive experiments conducted at the Massachusetts Experiment Station seem to show that the disease is not propagated by the seed, scabby seed producing healthy tubers and vice versa.

Those who have made this disease a careful study believe it is not due to animal or plant parasites, but is caused by the conditions of growth. Experiments conducted at the N. Y. Experiment Station to test the effects of soil, excessive moisture, chemical fertilizers and fresh stable manure upon the production of scab, seem to show that fresh manures and excessive moisture increase the disease. It appears that conditions favoring rapid growth also favor the production of scab. Much moisture in the spring followed by drought is believed to increase the disease, also a dry spring followed by a wet fall has the same effect. Uniform conditions during the season should decrease the disease, if the above is correct. It has been observed that potatoes grown in a moist atmosphere will have formed on their surface warty prominences. The skin of the potato is made of what botanists call *cork tissue*. It does not cover the tuber but at intervals there are minute structures called *lenticels* through which gases pass in and out of the potato. When the potato is exposed to excessive moisture these lenticels increase in size and the skin thickens near them, causing the warts spoken of above. If the conditions continue this warty tissue begins to decay and a scab is formed.

The loose tissues which compose these warts would be more easily affected than other portions of the skin by corroding substances or organic compounds that happen to be in the soil. Some believe the bite of an insect or mechanical injury of any kind will produce scabs. This may be true but some more uniform and general cause is necessary to account for the disease. There is quite a general belief in this State that chip-manure, excess of ashes, sawdust manure, lime or fresh manure will cause the disease but opinions are quite conflicting. It is probable that the most of these are apparent instead of real causes. The station desires to study this disease carefully and will be pleased to have potato growers who may be interested answer the following questions: kind of soil, location, drainage, old or new; crops the last two or three years; method of culture; fertilizers used and amount; kind of seed, scabby or not, time of planting and harvesting crop, product scabby or not. What conditions have you observed that seem to cause the disease.

From what has been observed it would be advisable to drain well the soil upon which potatoes are to be grown and keep it loose and porous. Avoid an excess of fertilizers that would produce in the soil corroding organic compounds. Harvest the potatoes as soon as matured.

INJURIOUS PLANTS.

Apple Scab or Black Spot—Fuisicladium Dendriticum.

Attention has been called to this fungus parasite as doing considerable damage to apples in the State. Apples marketed in Orono and Bangor have been examined and the disease found to be common in this region. We also learn that it is prevalent in other portions of the State. The disease is widespread over the country destroying in some of the States annually from one-half to one-sixth of the crop.

This fungus attacks the twigs, buds, leaves and fruit, but is most noticeable on the fruit, appearing as olive green spots, with a circular outline, which become velvety as they get older. When the fungus attacks the twigs and leaves it affects the vitality of the tree. The greatest injury is done to the fruit, the marketable product. An early attack causes the fruit to shrivel and drop—a later attack produces a withered stunted growth, while a late attack upon the full grown fruit discolors its surface and depreciates its marketable value, making it liable to rot under the scab spots when stored. The disease is worse in damp, cold seasons. It starts in the spring from germs that have lived over winter or from the plant body, which has retained its vitality in the twigs, fruit or fallen leaves. The cold, damp spring weather causes a rapid growth of spores which establish themselves upon the young fruit and leaves. The warm, dry summer weather arrests the growth which is continued again during the damp, cooler autumn months. The fungus shows some preference for certain varieties, but in bad seasons all are more or less affected. The parasite has a wonderful vitality and the plant body is probably perennial. We have now, January first, apples covered with the fungus in a vigorous growing condition. Specimens apparently dead when taken from the barrel kept moist a few days begin growth. It has been shown that the spores will germinate in about eight hours at the low temperature of 50° F., insuring an early start in the spring.

The successful treatment of this disease may be regarded as an open question but on account of the annual injury done should be carefully studied. The station wishes to conduct some experiments next season upon this disease and will be pleased to correspond with orchardists in different parts of the State where the disease was bad the past season and cooperate with them.

The life history of this fungus would suggest the application of some chemical by the spraying pump, early in the spring before the leaves start, to kill the spores as formed and prevent them attacking the young fruit and leaves.

Mr. Goff of the New York Experiment Station has tried spraying the trees early in the season with a solution of 1 pound of hyposulphate of soda to 10 gallons of water with good results.

Prof. Scribner suggests for trial the following treatment:

(1) Spray the trees early in the spring before the buds start with a solution made from 1 pound iron sulphate (copperas) and 1 gallon of water.

(2) After the fruit sets spray again with Bordeaux mixture prepared by dissolving 16 pounds copper sulphate (blue stone) in 22 gallons of water. In another vessel mix 30 pounds of lime with 6 gallons of water. After the latter cools pour the two preparations together and thoroughly mix them. It is best to prepare this mixture several days before it is needed and stir it well before applying

it. If the season is cold and damp a second application should be made later in the season. The spraying pump used to apply copper solutions should be made of copper and the valves of rubber.

To determine whether the spraying does good the application should be made only to alternate trees in the row or to one side of each tree. The effects upon the trees can thus be readily compared.

INJURIOUS INSECTS.

Quite a number of letters have been received at the station the past season asking information about insects doing injury in the State.

These letters in most cases were accompanied by specimens and were answered, when necessary, in detail giving habits, description and known remedies.

The number of letters received and the apparent want of information regarding insects doing damage to fruit and fruit trees in the State has convinced the writer that a condensed account of the characters, life history and known remedies of some of our common pests, would be acceptable to the fruit growers and farmers of the State.

In the account of insects given below we have gleaned the information from various sources and claim no originality, the object being to place in the hands of those who have not access to the writings of entomologists the means of identifying our common insects in all their stages and thus enable an intelligent warfare to be waged against them.

The cuts used to illustrate the insects considered were obtained from J. B. Lippincott & Co , of Philadelphia, and are electros after figures occurring in Saunder's Insects Injurious to Fruits.

Below is given a list of the insects that were reported and considered, together with the injuries attributed to them.

The most important of these have received attention in detail, while unimportant ones have not been illustrated and receive only passing notice.

List of Insects Reported and Examined.

	Common Name.	Scientific Name.	Depredations.
1	Round-headed Apple-tree Borer	Saperda candida, Fabr	Trunk of apple trees.
2	Flat-headed Apple-tree Borer	Chrysobothris femorata, Fabr	" "
3	Oyster-shell Bark Louse	Mytilaspis pomorum, Bouche	Branches of apple trees.
4	Apple-tree Tent-caterpillar	Clisiocampa Americana, Harris	Foliage "
5	Forest Tent-caterpillar	" sylvatica, "	" "
6	Fall Canker worm	Anisopteryx pometaria, "	" "
7	Eye-spotted Bud-moth	Tinetocera ocellana, Schiff	" "
8	Apple-tree Aphis	Aphis mali, Fabr	" "
9	Codling Moth	Carpocapsa pomonella, Linn	Fruit of "
10	Apple Maggot	Trypeta pomonella, Walsh	" "
11	Ash-gray Pinion	Lithophane antennata, Walker	" "
12	Pear-tree Slug	Selandria cerasi, Peck	Foliage of cherry and plum trees.
13	Indian Cetonia	Euphoria Inda, Linn	Injuries not mentioned.
14	Plum Curculio	Conotrachelus nenuphar, Herbst	Fruit of the apple tree.
15	Cherry-tree Plant-louse	Myzus cerasi, Fabr	Foliage of cherry trees.
16	Imported Currant-worm	Nematus ventricosus, Klug	" currant bushes.
17	Ivy Scale Insect	Aspidiotus Nerii, Bouche	" English ivy.
18	Black Swallow-tail Butterfly	Papilio Asterias, Cramer	Leaves of carrots and parsnips.
19	Eyed Elater	Alaus oculatus, Linn	Larva in apple-tree trunks.
20	Hawthorn Tingis	Corythuca arcuata	Foliage of butternut trees.
21	Mourning Cloak Butterfly	Vanessa antiopa, Linn	" elm trees.
22	Meal-worm Beetle	Tenebrio molitor	Larva in corn meal.

EXPLANATIONS.

By a *perfect insect* (*Imago*) is meant the form that lays the eggs. It is usually provided with wings, though the females of the bark lice and most plant lice, and the females of the fall canker-worm are wingless. The eggs hatch into the *larva*, i. e., the caterpillar, worm, grub or maggot, as the case may be. The larva changes to the *pupa* or *chrysalis*, which is the inactive or resting stage, and from the pupa the perfect insect comes forth. An insect in making a complete life history, would pass through four stages; the egg, larva, chrysalis and imago. The larva is the form that usually does the damage Unless otherwise stated the cuts shown are natural size. When the insect is shown enlarged the natural size is usually indicated by hair lines.

ROUND-HEADED APPLE-TREE BORER.

Saperda Candida, Fabr.

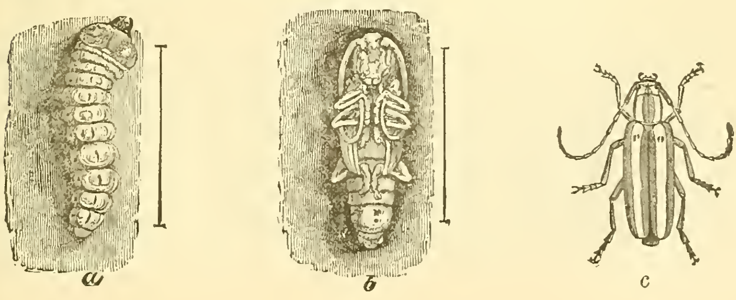
Complaints of injuries done by this common pest have been received from various parts of the State. One writer stated that he had taken fifteen larvæ from a single tree. The Round-headed Apple-tree Borer is a native of America and though it seems to prefer the apple, is known to affect the native crab, sugar-pear, thorn bushes, pear, quince and mountain-ash. It is widely distributed and does much damage unless carefully watched.

DESCRIPTION.

Perfect insect—A beetle about three-fourths of an inch long, with two broad white strips above running the whole length of the body—hoary white below, light brown above—legs and antenae gray. (Fig. 1, c.)

Larva—One inch long when full grown—footless. Whitish with a round chestnut colored head, polished and hornlike and armed with two black jaws. (Fig. 1, a.)

FIG. I.



Chrysalis—Lighter colored than the larva and with transverse rows of minute spines on the back. (Fig. 1, b.)

LIFE HISTORY.

The perfect insect makes its appearance in June and July, and remaining concealed during the day is not commonly seen. It becomes active at dusk and lays its eggs, one by one, on the bark, near the base of the tree. The eggs hatch in about two weeks, and the young worms begin at once to grow into the tree. The larva is three years changing to the beetle and injures the trees that length of time. The first year the larva works in the sapwood and inner bark, producing flat cavities filled with sawdust like coatings. The second summer the larva is about half grown and does great damage to the sapwood. At the close of the third season, it bores deeper into the wood making a cylindrical channel upward and then outward to the bark, filling the upper part with a powdery material. It retreats to the deepest part of the channel, fills up the passage below, turns around and waits until the following spring when it sheds its skin and becomes the chrysalis. (Fig. 1, b.) In two or three weeks the chrysalis changes to the beetle form, which opens the upper part of the channel, gnaws a hole through the bark, escapes, and in due time lays eggs, completing the life history.

REMEDIES.

The dark colored spots made in the bark where the young worms enter should be scraped until the light colored bark below is exposed and the larva found and destroyed. The best time to examine is early in September or a little later in our climate. Sometimes the bark of the dark colored spots cracks and the sawdust like coatings fall out or protrude showing the location of the worm. The earlier the worm is detected the better, as it is more easily removed when young, and less injury is done to the tree. The burrow becomes larger and deeper as the worm grows and can then be best reached by thrusting a stout wire into the hole, or opening it above and pouring in scalding water slowly, until it reaches the insect and kills it. The practice of digging out the larva from a deep channel is not to be recommended, as it does much injury to the tree. A preventive remedy is the best if an effective one can be found. Various substances have been applied to the trunk of the tree to prevent the beetle from depositing eggs. Entomologists are agreed that alkaline washes are the best. The following are cheap and effective remedies: Reduce soft soap to the consistence of a thick cream by adding a strong watery solution of washing soda. Lime is sometimes used with the soap and glue may be added to give adhesiveness. A solution of soap and carbolic acid has been highly recommended. Whatever solution is used should be applied thoroughly to the base of the tree and to the trunk as high as the crotches. The best time to make the application is during dry warm weather, so the solution will thoroughly dry before a rain. There should be two applications, one early in June and another early in July. The solution may be applied with an old broom or a whitewash brush.

The natural enemies of this insect are few. Woodpeckers are said to destroy them.

FLAT-HEADED APPLE-TREE BORER.

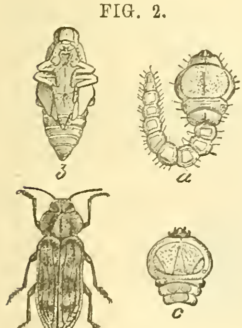
Chrysobothris Femorata, Fabr.

This pest is very common in Maine, and the injury attributed to the *round-headed borer* is frequently due to it.

It is a native of America and besides being the worst borer affecting the apple tree is known to attack the pear, plum, and peach; also the oak, box alder, hickorys, and maples. It loves the light and may frequently be seen about the orchard on the trees. It is very active and hard to catch, quickly taking wing.

DESCRIPTION.

FIG. 2.



Chrysobutheris femorata, Fabr. Flat-headed Apple-tree borer; a, larva; c, head of larva, underside; b, pupa; d, beetle.

Perfect insect—a beetle variable in size but usually about one-half inch long—oblong flattish in shape—of a dark, dull greenish color with a coppery reflection—under side and legs brilliant coppery color—feet green. On each wing case are two irregularly oblong impressed transversed spots of deeper copper color than the remainder of the wing, dividing the wing cases into nearly three equal portions. The upper surface appears as though sprinkled with an ash colored powder. The beetle somewhat enlarged is shown in (Fig. 2, d.)

Eggs — pale yellow, varied, with one end flattened, irregularly ribbed and 0.02 of an inch long.

Larva—soft, flesh-like, pale yellow ; head small, deeply set ; jaws black ; third segment twice as broad as any of the posterior ones, and bearing on its upper surface a large oval callous like projection covered with numerous raised brown points. (Fig 2, a and c.)

Chrysalis—lighter colored than the larva and with transverse rows of minute spines on the back and a few at the extremity of the body (Fig. 2, b.)

LIFE HISTORY.

The beetle makes its appearance in June or July in our latitude and lays probably about one hundred eggs. The female fastens the eggs, singly or in groups, to the loose flakes of bark or in the crevices, by means of a glutinous substance. The eggs soon hatch and the young worms gnaw through the bark and live on the sap wood making flat channels next to the bark, sometimes girdling the tree. As they get older they bore upward into the solid wood and when ready to change to the *chrysalis* gnaw to the bark and nearly through it. It then changes to the chrysalis (Fig. 2, b), and in about three weeks the beetle comes forth. The larva attacks the trunk and larger branches and is supposed to remain in the tree but one year.

REMEDIES.

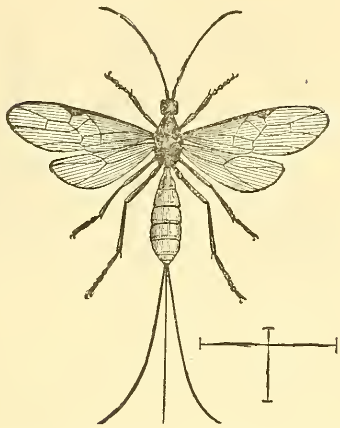
Examine the trees early in the fall for dark flattened spots, exudation of sap, or sawdust-like coatings, and if found remove the worm with a knife.

Catch and kill the beetles when possible. Paint the *trunk* and *larger branches* with the solution recommended for the *round-headed borer.*

Keep the trees as vigorous and healthy as possible as this borer prefers sickly trees and those recently transplanted or too severely pruned.

Remove the flakes and moss from the trunk and keep it as smooth as possible. This beetle is said to be worse in high, sandy soil than in rich, low ground. Anything that tends to give vigor to the tree lessens the danger of attack.

FIG. 3.



This pest is held in check by woodpeckers and insect parasite. Several species of four-winged flies called Ichneumons are known to prey upon the larva. In Fig. 3 is shown one of these parasites magnified, the crossed lines showing the natural size.

THE OYSTER-SHELL BARK-LOUSE.

Mytilaspis pomorum, Bouchè.

This pest is quite common about Orono, and letters have been received during the season regarding it from other parts of the State. It is a native of Europe introduced into this country on nursery stock nearly a hundred years ago, and is now widely distributed, doing great damage to the apple tree, and is known to affect the pear, plum and currant. It can be detected with the naked eye as minute brownish or greyish scales nearly the color of the bark. These scales are about one-sixth of an inch long, shaped somewhat like an oyster shell, and placed on the branches or twigs lengthwise with the small end usually upward. (Fig. 4.)

FIG. 4.

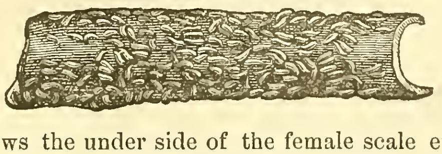
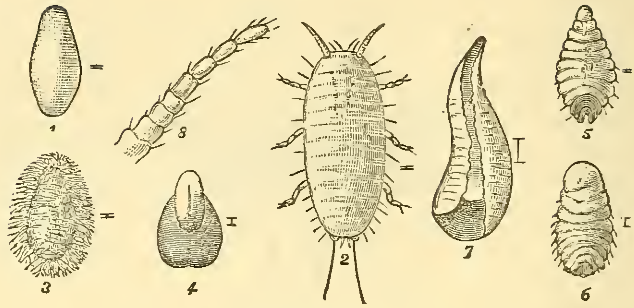


Fig 5-7 shows the under side of the female scale enlarged. As shown in the figure the bark is sometimes densely covered with the insects, producing great injury to the tree.

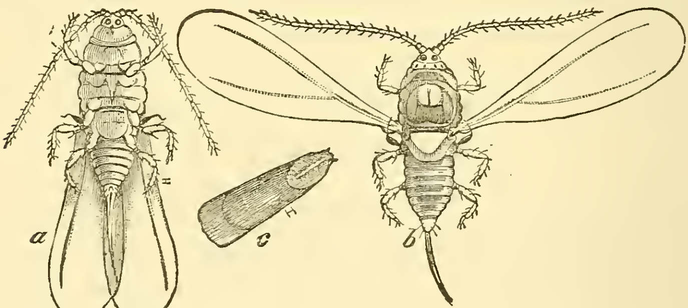
FIG. 5.



DESCRIPTION.

Perfect insect—The female louse is shown much magnified (Fig. 5-2.) The real length is about one hundredth of an inch, and they appear to the naked eye as mere specks. The *male* insect and its scale are shown in Fig. 6, much magnified.

FIG. 6.



The scales of the male are much smaller than the female scales and occurring more commonly on the leaves, are rarely seen. Eggs from twenty to one hundred are found under each scale. Early in winter they are white but toward the hatching time change to a yellowish hue. Fig. 5, 1, shows the egg much magnified. The eggs remain under the scales unchanged for nearly nine months, there being but one brood each season in the Northern States.

LIFE HISTORY.

Female.

The eggs hatch late in May or early in June. If the weather is cold the lice remain under the scale until warmer weather, and these may be seen running about the twigs for a location to attach themselves.

The most of these soon fix themselves around the base of the side shoots of the twigs by means of their tiny, slender beaks and live upon the sap of the tree. They gradually undergo changes shown in Fig. 5, 3, 4, 5 and 6. Before the close of the season the louse secretes the scale under which it lives and perfects itself.

By the middle of August the female becomes a bag of eggs, which are deposited in a mass under the scale, the body of the louse shriveling, as the eggs are laid, until it is a mere speck at the small end of the scale These eggs remain under the scale, if not destroyed, until the following spring and then hatch, completing the life history.

How this pest is spread from tree to tree is not well made out, but it is supposed that birds carry them on their feet and that large insects may transport them, or that the wind may blow them about. They are probably introduced into young orchards on the nursery stock and multiply.

REMEDIES.

Inspect carefully the nursery stock before setting and remove any scales that may be found. During the winter, examine the trees in the orchard and scrape off the scales found on the larger branches and twigs. In the spring watch for the young lice which may be seen crawling about on the twigs, and then brush the tree with the soap and soda solution mentioned for the borers, or spray the tree with a solution of one-half pound of soda to a pail of water.

This pest is held in check by quite a number of insect parasites. At least four small Cholcid Ichneumon flies are known to prey upon it. A species of mite so small that it can hardly be seen without a lens preys upon the louse and its eggs, and has done much to hold

it in check. The lady bird shown in Fig. 7, and its larva eat large numbers of the lice. (This small beetle has black wings with a blood red spot on each. The lava is a grayish worm covered with bristles and very active.) Insectivorous birds are supposed to eat some of the lice and their eggs.

THE APPLE-TREE TENT CATERPILLAR.

Clisiocampa Americana, Harris.

This insect has been very abundant the past season. As many as a dozen webs were counted on a single tree. The insect and its web are so conspicuous it is not difficult to keep it in check. There is no excuse for allowing the trees to be stripped of their foliage before the colony is destroyed.

The apple-tree tent caterpillar is a native of the northern Atlantic States and has been distributed to other parts of the country on nursery stock. It is now widely known and feeds upon the foliage of the plum, black cherry, apple and other trees.

FIG. 8.

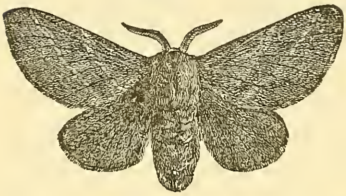


FIG. 9.

DESCRIPTION.

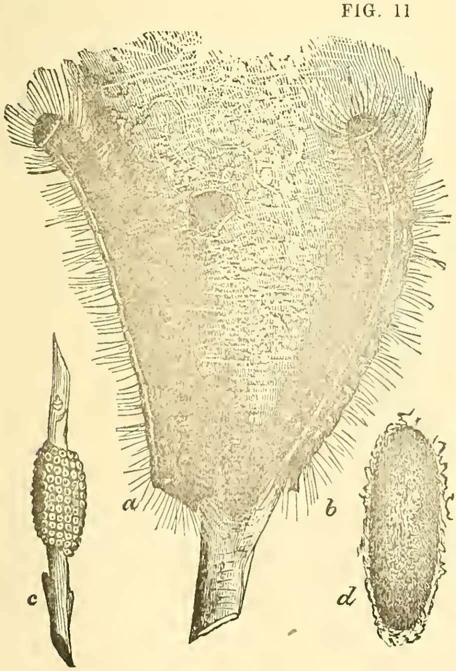
Perfect insect—a moth of a pale dull reddish or reddish brown color. The fore wings are crossed by two oblique parallel dirty white lines. The female is larger than the male. Their relative size is shown in Figs. 8 and 9. The male has feathery antenæ. The moth has no power of taking food and lives only a few days. Its office is to lay the eggs.

Eggs—from one to two hundred in number are laid, in clusters, composed of from ten to twenty rows, upon the smaller twigs. The eggs are conical about one-twentieth of an inch long. The clusters are covered over with a tenacious varnish that keeps out the rain. Fig. 10 shows an egg cluster with the varnish on, and Fig. 11, c, shows the arrangement of the eggs on the twig.

FIG. 10.

Larva—The young larva are fully formed—the eggs in the fall remain dormant until the first warm days of spring and then hatch. They can be made to hatch in the winter by bringing the clusters to the fire. When first hatched they eat the gummy portions of the egg cluster covering, and if the leaves have not appeared can go several days without food. Worms hatched last spring in the house wandered about the twig for over a week before they died, after having eaten all the varnish, leaving the egg-shells bare. The larvæ early begin to construct their web which is increased in size by additional layers of silk as the worms grow, until it is sometimes ten inches or more across. The worms remain in the tent at night during stormy weather and when not feeding, unless the weather is warm when they may be seen upon the outside literally covering the web. They march in military order twice a day from the nest to feed, once in the morning and once in the afternoon. They pave their roads with silk and follow along them to the leaves. When mature each worm will consume two leaves a day and an average of five hundred leaves would be required for a colony. There are often several webs in a tree. The effects are to rapidly defoliate the tree and draw heavily upon its vitality to produce new leaves. The caterpillars require about six weeks to mature and are then about an inch and three-fourths long, and have the appearance shown in Fig. 11, a and b. The worms have a "white line along the back; then a yellow line dotted with black; then a black stripe marked with blue and yellow dots; then a wavy yellow line dotted with black; then a blue stripe dotted with yellow; then a broken white line; head black; under side of body black; the body covered with yellowish or whitish hairs."

FIG. 11



11

When mature, the larvæ leave the tree and wander about in search of a place to spin their cocoons. They prefer the loose bark of trees, the under side of fence caps and will enter sheds and porches and climb the sides of houses and transform under the edge of clapboards, window caps and eaves. When the orchard is near they become a nuisance by entering the house.

Cocoons—Oblong oval, light yellow formed of a loosely woven outer covering and a dense tough inner coat. The lava enclosed becomes a brown chrysalis and in about two to three weeks the moth comes forth. The cocoon is shown in Fig. 11, d.

LIFE HISTORY.

The moths appear early in July and in a few days lay their eggs upon the twigs as described above. Early in the spring when the buds are opening, the eggs hatch. The caterpillars live on the leaves and require about six weeks to mature. They then spin their cocoons from which the moth emerges in two or three weeks completing the life history.

REMEDIES.

Pick off the egg clusters during the winter. Should any colonies hatch in the spring as soon as the web is noticed, remove it late in the evening or early in the morning when the caterpillars are at rest. The nest may be reached with a ladder and taken off with a gloved hand and the larva crushed; or a bunch of rags can be tied to the end of a pole and the nest removed. The orchard should be examined from time to time for a month or six weeks. The worms should be killed or they will climb the trees again. This pest has quite a number of natural enemies which keep it in check.

A minute Ichneumon fly only one twenty-fifth of an inch long is parasitic on the eggs. One cluster of eggs examined last spring hatched only about a dozen caterpillars and in a few days nearly seventy-five of these small Ichneumon flies emerged.

FIG. 12

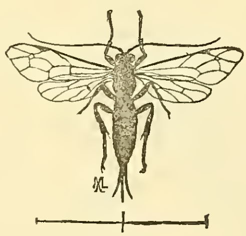
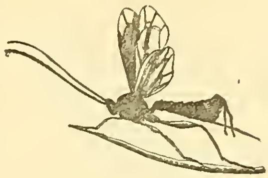


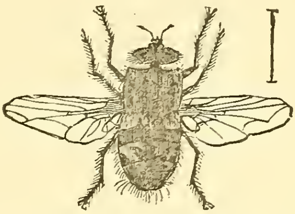
Fig. 12 represents a large Ichneumon fly that preys upon the caterpillars. We hatched last spring from a cocoon an Ichneumon fly shown in Fig. 13.

FIG. 13.



There is shown enlarged in Fig. 14 a species of two-winged fly known as a *Tachina fly*, which preys upon its caterpillars.

FIG. 14.



The above parasites deposit their eggs in the eggs, or upon, or within the bodies of the living caterpillars, destroying them. Several species of the ground beetles prey upon the caterpillars.

FIG. 15.

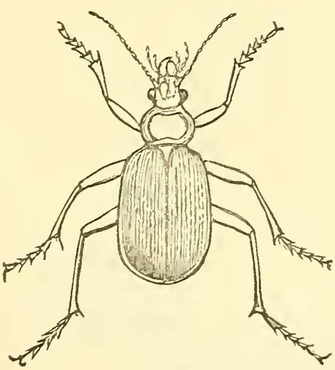
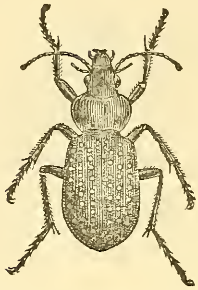


Fig. 15 represents one of these, the Green Caterpillar Hunter, which may be distinguished by its large size and bright green wing covers.

FIG. 16.



In Fig. 16 is shown the Copper-Spotted Colisoma, which feeds upon the caterpillars. It may be known by its large size and three rows of copper-colored spots on each wing cover.

There is a mite similar to the one that eats the eggs of the Oyster-shell Bark-louse that feeds upon the eggs of this species. Insectiverous birds eat the larva. This season we noticed the White-eyed Vireo capture and eat eight half-grown caterpillars at one feeding. It would approach the tent and while on the wing seize a caterpillar and retire to a branch close by and eat it, and soon return again

FOREST TENT CATERPILLAR.

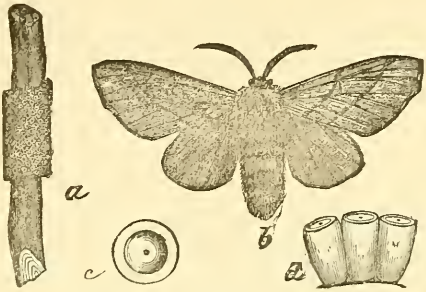
Clisiocampa Sylvatica, Harris.

This species closely resembles the tent caterpillar of the apple tree, and like it constructs a tent. They are often found on the same tree in the orchard. This insect feeds on the hickory, walnut, rose, oak, poplar, ash and other forest trees and also on the apple, plum. peach and cherry. It is a voracious feeder and does much damage to the foliage of forest and fruit trees.

DESCRIPTION.

Perfect insect—A moth which expands an inch and a half or more. Wings, brownish yellow. The fore wings with two oblique lines as in the apple-tree tent caterpillar, but brown instead of white and the space between them darker than the rest of the wing. Fig. 17, b.

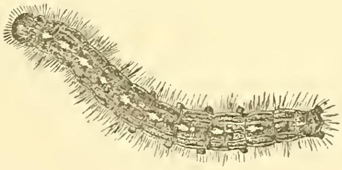
FIG 17.



Eggs—White—one twenty-fifth of an inch long, tapering toward the base; margin at the top rimmed-centre with a depressed spot; deposited around the twigs like the eggs of the above species and distinguished from them by the cluster being square at the end and uniform in diameter; clusters contain three or four hundred eggs. (Fig. 17, a) shows an egg cluster, (Fig. 17, c and d) eggs, both magnified. The eggs are stuck together and to the twig by a brown varnish.

Larva—Pale blue tinged with only greenish low down on the sides and everywhere sprinkled over with black points and dots. Along the middle of the back is a row of white spots and on each side of these an orange yellow or tawny reddish stripe, and a pale cream yellow stripe lower down on each side. These stripes and spots are margined with black. Each segment has two elevated black points on the back from each of which arise four or more coarse black hairs. Back clothed with fox colored hairs, sides low down clothed with whitish hairs. Head, dark bluish freckled with black dots and clothed with black and fox colored hairs. Legs black, clothed with whitish hairs.

FIG. 18



When full grown, the larva spins a cocoon closely resembling that of the ordinary tent caterpillar. They usually spin the whitish yellow cocoon in the shelter of a leaf, but if leaves cannot be had for shelter they are placed under loose bark of trees, about fences or under rubbish. The *chrysalis* is formed in the cocoon in two or three days and is of a reddish brown color, densely clothed with short pale yellowish hairs.

LIFE HISTORY.

The eggs hatch about the time the buds burst and like the previous species the larva can go for some time without food. While young, they spin a slight web upon the trunk or branches which is not usually noticed. The larva while young manifest a propensity to military movements, marching about in single or double file, and when older wander about for exercise and food. They become full grown in six weeks and soon spin a cocoon, as mentioned above, from which the moth appears in two or three weeks and soon lays its eggs, completing the life history.

REMEDIES.

Pick the egg clusters in winter. Knock the trees and the young larva will suspend themselves by threads and can be removed by swinging a stick to which the threads become attached. Put cotton bands about the trunks to keep the wandering caterpillars from ascending other trees. The natural enemies are numerous and hold them in check.

FALL CANKER-WORM.

Anisopterix pometaria, Harris.

The eggs and female of this species were received at the station this season. The female was taken in the act of depositing eggs on an apple tree. The moths were quite plentiful about Orono last fall This species has been known for a long time to feed on the foliage of the apple tree, and also to attack the elm, cherry, peach, &c The females being wingless and not being able to travel far, this pest is usually local in its attacks. Whether it does much damage in Maine we do not know, but regard it important that its habits be known.

DESCRIPTION.

Perfect insect—(Male.) A moth provided with wings, the fore wings, brownish gray, glossy, crossed by two whitish irregular bands, the outer one enlarging into a large pale spot at the apex.

Hind wings greyish brown with a white band crossing them, and in the centre a faint blackish dot. Fig. 19, a.

Female—Wingless; uniform shining ash color above, gray beneath; length three to four-tenths of an inch. The female has a sluggish movement and a spider like appearance.

FIG. 19.

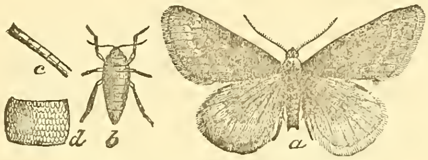
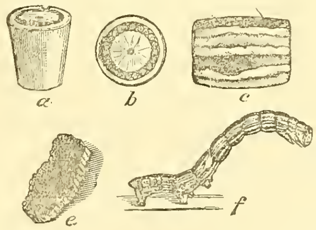


Fig. 19, b. represents the female natural size.

Eggs—Grayish, flattened above, with a central puncture and a brown circle near the border. Each female lays 100 or 200 eggs in rows arranged in clusters on the twigs or branches, usually in exposed situations.

In Fig. 19 d. and Fig. 20 e. are shown egg clusters natural size. The eggs magnified are shown in Fig. 20, a. and b.

FIG. 20.



Larva—Pale olive green when young, but varying in color, when grown, from greenish yellow to dark brown. Dorsal band broad, brownish; lateral lines three, white, the middle one paler; broad brown bands below the lateral lines, and below that a broad white band. Under side, flesh-colored; head brown.

These caterpillars belong to the group of inch or measuring worms, because they alternately loop and extend the body in moving. When at rest they sometimes assume the position shown in Fig. 20, f. and can hardly be told from twigs. Fig. 20, c. shows one of the segments of the body magnified, and Fig. 20 f. the larva full grown. When full grown they are about one inch long. When mature they crawl down the trunk or let themselves to the ground by a silken thread, and burrow to a depth of from two to six inches. They make a tough cocoon of buff colored silk interwoven with earth, and in twenty-four hours turn into the chrysalis.

The *Chrysalis* are light grayish brown and about half an inch long. The *male* slender and provided with wing cases; the female larger and without wing cases.

LIFE HISTORY.

The eggs hatch about the time the buds on the apple trees expand. The young worms feed upon the tender leaves, seeking shelter within the expanding flowers or buds when the weather is wet or cold. They eat holes in the leaves while young, but when older devour the whole pulp of the leaf leaving only the veins and midrib. They feed for about four weeks, and when plentiful so destroy the foliage as to give the trees the appearance of having been scorched with fire. They have done great damage to foliage trees along highways. While letting themselves down to the ground they are often swept off by carriages and carried long distances.

The larva enter the ground, spin a cocoon, are converted immediately into the chrysalis state, from which, during the fall, winter and following spring they emerge in the perfect form, completing the life history.

REMEDIES.

Destroy the egg clusters when seen. Kill the moths when found about the orchard. Jar the trees and destroy the larva that suspend themselves by threads.

Prevent the wingless females from ascending the trees, and the larvæ from descending or ascending. This may be done by means of sticky substances bandaged to the tree, by troughs filled with oil, or by collars of metal, wood or glass fastened to the tree and sloping downward like an inverted funnel. Among the sticky substances that have been used are included tar mixed with oil, refuse molasses, printer's ink, lard and sulphur and slow drying varnishes. The best way to apply these is to put them on a strip of stiff paper or canvas six inches wide tied by the middle around the tree a few inches above the ground.

Troughs can be made of rubber, tin or lead, and put around the trunk and kept full of oil. A good collar can be made from a tin band somewhat larger than the trunk, to the top of which is attached a piece of cotton cloth by which it is fastened to the tree making an inverted funnel.

Whatever apparatus is used care should be taken to stop any holes made by irregularities of the bark or trunk. Cotton batting, straw or rags can be used for this purpose. When sticky substances are applied they should be renewed occasionally during the time the moths ascend or the larva descend. This involves considerable time but pays

Fall plowing has been recommended to expose the cocoons to the weather and birds. Hogs are said to root up the chrysalis and eat them.

Canker worms are preyed upon by a species of mite, by ichneumons, a tachina fly, a wasp, a soldier bug, and by several species of pedaceous beetles, which help hold them in check. Insect eating birds devour them.

THE EYE-SPOTTED BUD-MOTH.

Tinetocera Ocellana, (Schiff).

Attention was called last spring to an insect doing injury to the terminal buds of apple trees in the college orchard, and about a hundred larvæ were taken from a single tree, part of which were allowed to transform and proved to be the species named above. We also noticed in the orchard of Mrs. A. A. Sutton of Orono several young trees so badly affected by this insect that nearly all the terminal cluster had turned brown. If as plentiful elsewhere it must do considerable damage. It does not confine its depredations to the leaf clusters but will attack the flower clusters and even the newly-formed fruit; also the small twigs from which the blossoms come, tunneling them down the center, causing their death. It does not confine its mischief to the apple, but attacks also the cherry and plum.

Perfect Insect—A moth of an ash gray color which expands half an inch. Fore wings banded across the middle with whitish gray, and each wing bearing two small eye-like spots, one near the tip, composed of four little black marks on a light brown ground, the other formed of three minute black spots arranged in a triangle and located near the hind angle. Hind wings dusky brown. The moth natural size is shown in Fig. 21.

Eggs—We do not know the eggs of this species but presume they are laid by the moth on the twigs or terminal buds and hatch early in the spring.

Larva—Three-fourths of an inch long, cylindrical, naked, pale dull brown, body bearing warts from which arise fine short hairs; head and top of next segment black. The larva occupies a dry blackened leaf, portions of which are drawn together so as to make a case which is lined with silk. Within this case the larva changes to a dark brown chrysalis in June. The larva is shown in Fig. 21.

LIFE HISTORY.

Eggs laid on the terminal buds or twigs in the summer and remains until the next spring hatching about the time the leaves expand. The larvæ attack the terminal leaf clusters, flower clusters, young fruit or twigs and feed upon them until full grown in June when they spin a cocoon within the case and emerge the perfect moth early in July, completing the life history.

REMEDIES.

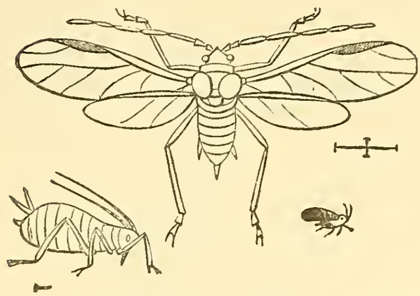
Hand pick the clusters of injured leaves which can readily be seen on the trees in June, being changed in color, drawn together by silken threads. Spraying the trees, for the codling moth would probably destroy this insect.

THE APPLE-TREE APHIS.

Aphis mali, Fabr.

Several complaints have been received the past season of depredations by the above species, and we judge it is quite widely distributed in the State. It is an insect that feeds upon the juices of the foliage and when at all abundant must seriously affect the vitality of the tree This insect was originally from Europe, but is now a pest in apple orchards throughout the Northern United States and Canada. *Perfect insect* (*male*) head, thorax and antenæ black, neck usually green; abdomen, short, thick, oval, bright green; sides with row of black dots; nectaries and tail-like appendages black; wings transparent with dark brown veins. The *winged female* resembles the male in color. Perfect insect (*wingless female*)—length less than one-tenth inch; body oval, pale yellowish green, often striped with deeper green; eyes and tail appendages black; honey tubes green.

FIG. 22



The winged male and wingless female are shown highly magnified in Fig. 22. The real size is indicated by hair lines.

Eggs—Minute. oval, light yellow or greenish when first laid but gradually change to shining black.

Young insects—Produced alive, nearly white when born but soon become yellowish green.

LIFE HISTORY.

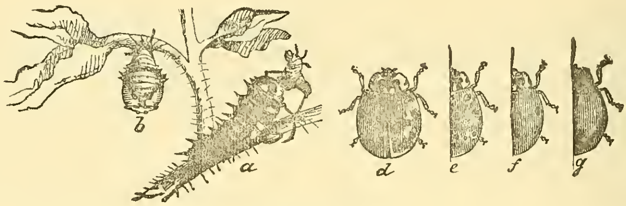
The eggs are deposited in the autumn in the cracks of the bark of twigs and at the base of the buds. The eggs hatch when the buds begin to expand and the lice locate themselves on the young buds and leaves by means of their beaks and feed upon the juices. The spring brood is composed of females and is about ten days reaching maturity. Each louse gives birth to living young, producing about two a day for two or three weeks and then dies. These young become mothers in about ten days and produce. This process is continued through the season, there being many generations mostly wingless females, and without the appearance of males. Winged females are sometimes produced and migrating to other trees spread the pest. Late in the season males are produced with the females and eggs are laid to perpetuate the species, thus completing the life history.

REMEDIES

Spray the trees, about the time the buds are expanding, with strong soap suds, or a decoction of tobacco stems or leaves one pound to a gallon of water. Spraying the tree for the codling moth with Paris Green would probably destroy some of the plant lice. The presence of plant lice is indicated by ants which ascend the trees to feast upon the honey-dew secreted by the lice. The plant lice have two projections, one from each side of the hinder part of the body, called nectaries or honey tubes from which a sweet fluid is secreted in some quantity. Ants gather in great numbers to feed upon it and will even strike the lice with their antenæ causing them to give out the fluid. The normal use of this fluid is probably to feed the young lice.

The natural enemies of the plant lice are many. Several species of lady-birds prey upon them. One of these, the Fifteen-spotted Lady-bird is shown in Fig. 23, where the larve (a), chrysalis (b),

FIG. 23.



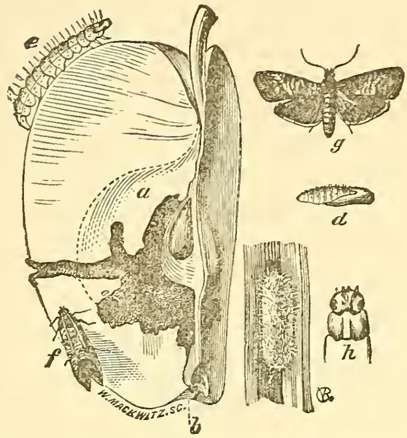
and several forms of the perfect insect (d, e, f, g) are represented. The larva of the Lace-winged or Golden-eyed Flies feed upon the plant lice. These flies may be known by their light green gauzy wings and offensive odor when disturbed. Their eggs are raised on little stalks and are found in clusters. The larva of the Syrphus Flies also devour plant lice. These flies deposit their eggs among the plant lice and the blind larva hatched from them wander about devouring any lice they chance to meet. These flies may be known by their black color, clear wings and yellow stripes crossing the body. A tree affected by plant lice can be distinguished by the twigs and leaves being distorted and twisted backward. The lice find shelter under the distorted leaves. Scraping the loose bark from the trunks and branches in the winter and washing with soap suds will help destoy the eggs.

THE CODDLING MOTH.

Corpocopea Pomonella, (Linn.).

The habits of this pest are too well known to need detailed description. We give a figure which shows the perfect insect (g)

FIG. 24.



expanded and the same with closed wings at (f). The larva is shown at (e) full grown. At d. is shown the chrysalis; at (i) the cocoon, at (h) the head of the larva enlarged. The entrance of the larva at the colyx of the apple is shown at (b). The dark shaded portions of the figure represent the borings of the larva and the hole at the side the place where the full grown larva escaped.

LIFE HISTORY.

First Brood.—The eggs are laid singly in the eye of the apple when about the size of a pea, or occasionally at the stem end or even on the cheek. Sometimes two or more larvæ occupy the same fruit. The eggs hatch in about a week and the larvæ bore toward the core, feeding upon the material round it, finally escaping through the side. The larva requires about four weeks to mature. The fruit affected falls prematurely. If the larva attains its growth before the fruit falls it lets itself to the ground by a silken thread or crawls down the branches to the trunk. Those that let themselves down or fall with the fruit generally crawl along the ground to the trunk where they with the others conceal themselves in the crevices or cracks of the bark, spin a cocoon which they cover with small pieces of bark or other available material. The change in the chrysalis takes place in about three days. The moth emerges in about two weeks, is capable of laying about fifty eggs, which are deposited from time to time for two weeks or more.

The *Second brood* is generally on the wing the latter part of July. The moths of the first brood not appearing all at the same time and the great length of time required for the female to lay her eggs would give larva of all ages and cause the broods to lap over each other. The second brood generally deposit their eggs in the late apples and if the larva are matured before gathering time they leave the fruit and spin cocoons as mentioned above, but when taken to the cellar they spin their cocoons between the staves and hoops of the barrels or about the bins.

The fall brood remains in the larval form within the cocoon until spring, when it emerges, completing the life history.

It would seem from the investigations of Mr. Charles G. Atkins, recorded in Agriculture of Maine, 1883, p. 356, that in this State we sometimes have but one brood of the Codling Moth. My observations the past season indicate two broods, lapping over each other so as to indicate that eggs are deposited in July, August, September and the first part of October. Larva one-half grown were found in November.

REMEDIES.

The modern and perhaps best way to hold in check this pest is to spray the trees, about the time the apples are forming, with Paris Green suspended in water, by means of a force pump There should be at least two applications covering the time of emergence of the moths and the period of laying eggs. If there is but one brood or only a feeble second brood this method would be more efficient in Maine than where two broods occur. As most of the larvæ escape from the apples before they fall, the custom of gathering windfalls to destroy this insect cannot prove effectual, though it is recommended as a help. The apples should, however, not be allowed to remain long on the ground. They harbor the larvæ of other insects which would be destroyed at the same time

About the first of June fasten around the trunks of the trees bandages of straw, cloth or paper. The larvæ will seek these bands to spin their cocoons. The bands should remain until after the second brood spins and be examined for worms and cocoons every few days. The bands should also be used when spraying is done as a means of destroying the second brood should it appear.

Barrels in which apples have been stored should be examined and the cocoons destroyed. The natural enemies are few, though ichneumon flies, ground beetles and other insects and insectivorous birds, help keep them in check.

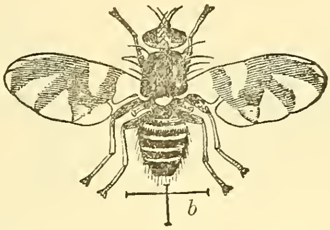
THE APPLE MAGGOT.

Trypeta pomonella, Walsh.

Extensive observations were made the past season on this troublesome insect and considerable knowledge gained of its life history. As our investigations are not completed we defer an exhaustive consideration until another time.

That the two-winged fly which lays the eggs may be known we figure it and describe it.

FIG. 25.



The perfect insect is a two-winged fly from one-fifth to one-fourth inch long, and is easily recognized by the black bands across the wings, the rust-red head, black eyes, white spot on the back part of the thorax and white bands on the abdomen. The female is shown enlarged in Fig. 25. The flies appear on the wing in July in this region. The minute larvæ, just hatched, were observed about August first, when the apples were nearly an inch in diameter. We would like to have those who are interested in the matter note the appearance of this fly and report, sending live specimens if possible enclosed in a small bottle or box.

REMEDIES.

As the larvæ go through their transformations near the surface of the ground and often do not enter the ground at all but hide under sticks and about the roots of grass it would seem that plowing would destroy a great many by covering them so deep they would not be able to reach the surface. The larvæ do not leave the apples before the windfalls drop, and therefore the gathering of them would destroy a great many.

We do not think spraying when the apples are small, as is done for the Codling Moth, would do any good as the fly does not deposit its egg until the apples are of considerable size.

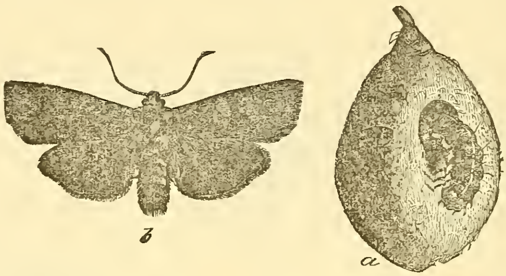
To leave the apples of affected trees ungathered, or to turn upon the ground those found to be infested would multiply the pest.

ASH-GRAY PINION.

Lithophane antennata, (Walker.)

Though not abundant we found quite a number of apples the past season apparently injured by this insect. The perfect insect is a moth. It is the larva that does the injury by boring into the the young fruit.

FIG. 26



In Fig. 26 is shown the moth and the larva at work. The moth is dull ash-gray color with variegated fore wings. The larva pale green, spotted with cream color and with a broad lateral band of the same shade. Hand picking is the only remedy we know or can suggest.

THE PEAR TREE SLUG.

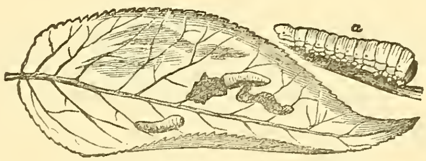
Selandria cerasi, Peck.

Specimens of the above insect were received the past season and reported as doing great injury to the foliage of cherry and plum trees. Mr. Eben Bickford of South Newburgh says, "they appeared on my cherry trees about ten or twelve years ago and destroyed my trees in two or three years. *Eternal vigilence* has been the price of cherries since. I have found no one who has seen anything like them, and I send them to you in hopes you will be able to name them and suggest a remedy. They will live on and destroy Damson plum trees when they cannot get cherry, but I have not seen them on any other. They do not travel far, as my neighbors, only twenty or thirty rods off, do not have them."

This pest was fully considered in 1790 by Prof. Peck of Mass., in an article entitled "Natural History of the Slug worm" which was awarded a premium of fifty dollars and a gold medal by the Masssachusetts Agricultural Society. This insect has spread over the greater portion of the Unitel States and Canada and feeds upon the foliage of the pear, quince, plum, and cherry doing more or less injury. Though called the pear slug it seems to prefer the foliage of the cherry.

FIG 27.

FIG. 28.



DESCRIPTION.

Perfect insect—A four-winged fly of a glossy black color. The wings are transparant with brownish veins and the fore wings crossed by dusky markings ; legs dull yellow with black thighs, excepting the hind pair which is yellow in the middle and black at the extremeties. The female is about one-fifth inch long and the male smaller. The perfect insect is shown in Fig. 27, enlarged.

The eggs are small and deposited singly within semi-circular incisions made in the skin of the leaf upon the upper or under side.

The larva or slug when grown is about half an inch long, slimy, blackish or olive brown ; head end smaller ; head small, reddish, and nearly concealed under the first segment of the body. The young larva is white, but soon becomes olive colored and slimy. The last time it molts it elongates, loses it slimy appearance and becomes clear yellow or reddish yellow, and soon crawls or falls to the ground, buries itself from one to four inches and changes to the chrysalis stage. It does not spin a cocoon but forms an oval cavity in the earth and cements it together with slime, thus forming a chamber within which it transforms. The larva is shown natural size and enlarged in Fig. 28.

LIFE HISTORY.

The flies appear the last of May or early in June and deposit their eggs as described above. The eggs hatch in about two weeks. The slugs change their skin four or five times and come to maturity in about a month, crawl to the ground, change to chrysalis state, from which the flies emerge in two weeks. These flies immediately lay eggs for a second brood, which hatches early in August. These larvæ mature in due time, enter the ground where they remain during the winter and emerge the following spring, completing the life history.

REMEDIES.

The flies feign death when disturbed and can be shaken from the trees and caught on cloth and destroyed. The best time to shake trees is early in the morning or late in the evening.

Spray the trees with hellebore and water, one ounce to a pailful. Dust the trees with air-slacked lime. Sand, ashes and road dust seem to be of no value. If the trees are not bearing, the first brood could be killed by spraying with Paris Green and the second brood could always be killed that way, as the larva hatch after the fruit is gathered. The slugs are so slimy and have such a disgusting odor they are not eaten by birds and have few natural enemies, though the maggot of a small species of ichneumon fly is parasitic on the eggs. These flies are usually local in their injuries and much more common some years than others.

THE PLUM CURCULIO.

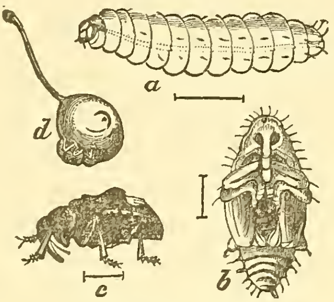
Conotrachelus nenuphar, Herbst.

This insect which is well known as the worst enemy to the plum grower was observed the past season as doing considerable damage to the apple. From ten to twenty-five per cent of the early apples examined in July showed the characteristic cut of this insect.

Quite a large number of apples of the earlier varieties examined for the apple maggot were found punctured and infested by the larva of the above species. After the first of August the cuts we found made by this insect were few and we are led to believe they prefer the earlier varieties and that the apples punctured do not mature. We found also that a very large per cent of the larvæ which hatched did not reach maturity, as quite a number of dead larvæ were found in the fruit and but very few reached maturity and transformed. We however succeeded in transforming enough to identify the species. It would seem that the plum curculio does not flourish well in the apple and attacks it in the absence of its favorite fruit. The decline in the cultivation of plums due to the ravages of this pest and the black knot will account for its attacking apples.

When the trees are full the apples that are punctured and drop would not lesson the crop, but with light bearers and in seasons when the bloom is scarce the damage would be considerable. This insect is known to infest the plum, peach, nectarine, apricot, cherry, apple and pear. The plum curculio is a native of this country and originally fed upon the wild plums, and still infests them. The males and females both puncture the fruit to feed on it but only the latter make the crescent shaped cuts.

FIG. 29.



DESCRIPTIONS.

Perfect Insect—A beetle belonging to the family of insects known as weavils or snout beetles. It is blackish or grayish, rough, with a black shining hump on each wing case near the middle, behind which, is a dull ochre-yellow band marked with whitish about the middle; each thigh has two small teeth on the under side; snout short. Length of insect about one-fifth of an inch. Shown in Fig. 29 c. enlarged.

Egg—Oblong-oval, pearly white, visible to the naked eye, and can be found readily by examining the crescent-shaped cut made by the female.

Larva—When young, tiny, soft, footless; head distinct, horny. When full grown it is usually of a glossy yellowish-white, but varies in color with the food; head light brown or yellowish, along each side is a light line, below which is a row of black bristles and above it a less distinct one, and toward the hind extremity a few pale hairs; length about two-fifths of an inch. Shown enlarged in Fig. 29 a. The larva is so transparent the internal organs are plainly seen through the skin, imparting a reddish color to the central parts of the body.

The chrysalis is shown enlarged in Fig. 29 b.

LIFE HISTORY.

The beetles hybernate in secluded spots during the winter and appear on the wing about the time the plum trees blossom and, as soon as the young fruit forms begin to deposit their eggs. The female when about to lay an egg makes a minute incision with her jaws and then inserting the snout, enlarges the hole sufficiently to hold the egg, turns around, deposits the egg, thrusts it to the bottom of the hole with the snout, then cuts a crescent-shaped incision around one side of the opening, as shown in Fig. 28, d.

Only one egg is laid in a place, though on the apple, several punctures may occur on the same fruit. Each beetle lays from fifty to one hundred eggs and deposits from five to ten a day. The time of depositing eggs by early and late beetles probably occupies about two months. The first apples examined July first were badly punctured and no new cuts were found after the twentieth of the month. The eggs hatch in a few days and the larva is full grown in from three to five weeks. The infested apples or plums usually drop to the ground before the larva is grown and when mature it leaves the fruit, enters the ground four to six inches, forms an oval cavity, changes to the chrysalis and in from three to six weeks the perfect insect is formed and makes its way to the surface, completing the life history. There seems to be some reason for believing a few remain in the ground all winter. The specimens we transformed appeared in September, about four weeks from the time the larva was matured. We are inclined to believe that those apples in which the egg hatches and the larva grows, drop early. Abortive cuts shrivel and deface the fruit and check its growth but it may mature.

REMEDIES.

Jar the trees and catch the beetles that fall on sheets spread under the tree. The jarring should begin early, as the beetles appear with the blossoms, and be continued morning and evening for a month, or until the beetles become scarce. Dr. Hull of Illinois devised a "Curculio Catcher" which consists of an inverted umbrella on a wheelbarrow and provided with a slit in one side to receive the trunk of the tree. The machine is provided with a padded bumper in front and is driven against the tree with force enough to dislodge the beetles and cause them to fall into the umbrella from which they are collected and destroyed.

Gather the fallen fruit as soon as it drops or turn hogs in to devour it. Poultry allowed to run in the orchard will destroy a good many. Keep the ground clean under the trees as the beetles hybernate under rubbish. If the ground is clean, chips, pieces of cloth or shingles can be placed under the trees and examined occasionally for the beetles that hide under them. Plum orchards should be as far from groves of timber as possible, as the beetles find shelter in the woods and are apt to be more numerous than in open ground.

Prof. S. A. Forbes in Trans. Department of Agriculture, Illinois, Vol. 23, 1885, p. 26 in the Appendix, records experiments with Paris Green and lime suspended in water to determine their usefulness in protecting the apple from the attacks of the plum curculio; 2418 apples from trees sprayed with Paris Green were compared with 2964 apples from check trees not sprayed, and it was found that 27.3 per cent of those poisoned had been infested by curculios while of those not poisoned 51.3 per cent were affected. This would seem to show that the spraying saved nearly one-half of those that would have been injured. This method has the advantage of destroying a great many codling moths at the same time, as well as other insects. The experiments with lime seemed to show the destruction of about 25 per cent of the curculios, making it less efficient than Paris Green.

Quite a number of insect enemies help hold this pest in check. Among these are two or three species of ground beetles, the larva of the common soldier beetle, larvæ of the lace-wing flies, minute yellow Thrips and two species of ichneumon flies. The larvæ of the ground beetles, soldier beetle and lace-wing flies, and the ichneumon flies, prey upon the larva of the plum curculio. The Thrips mentioned devours the eggs.

THE CHERRY TREE PLANT LOUSE.

Myzus cerasi, (Fabr)

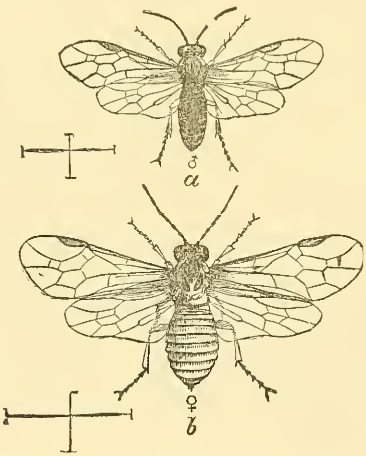
Specimens of this insect were received the past season with complaints of its doing injury to the foliage of the cherry trees. The leaves and stems sent us were literally black with the lice. This species like all the plant lice multiplies rapidly. Dr. Fitch estimated that there were at least twelve millions of these insects on a single small cherry tree. The life history is essentially the same as that given for the apple tree aphis and the natural enemies and remedies about the same. Spraying the trees with lye, soap suds or tobacco water about the time the leaves are unfolding, and once again later if necessary, would kill the most of them. The spray should be directed under the leaves as much as possible so as to reach them. Spraying with Paris Green early in the season would probably kill the lice as well as other insects. Some have tried colonizing lady-birds upon the trees with satisfactory results.

THE IMPORTED CURRANT-WORM.

Nematus ventricosus, Klug.

Attention has been called to this insect as doing injury to gooseberry bushes. We give cuts of the perfect insect (Fig. 30) which

FIG. 30.



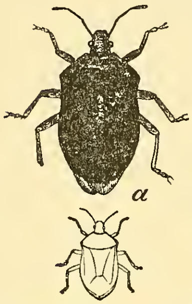
is four winged and known as a saw fly, the larva at work on the leaves (Fig. 31.) and a leaf (Fig. 32) showing the holes made by the young larva.

FIG. 31.

FIG. 32.

The consideration of this and other insects doing injury to currants and gooseberries is deferred, until we have more data. The station will be pleased to receive specimens of insects doing injury to the above plants. Below we give the remedies known for the currant worm. Spray the bushes well with powdered hellebore in water, one ounce to the pailful. Shower the bushes with water a little hotter than the hand can bear and destroy the worms that are dislodged and drop to the ground. Hand pick the leaves when the larvæ are young and grouped on them. The young larvæ are to be found usually on the lower leaves of the bushes and can be detected by the holes in the leaves as shown in Fig. 31. The application of the hot water would probably destroy a great many plant lice which are said to be doing considerable damage to the gooseberry bushes in the nursery rows in Aroostook county. Several natural enemies keep the currant worms in check. A small ichneumon fly is known to be parasitic on the eggs, and other species destroy the larva.

FIG. 33.



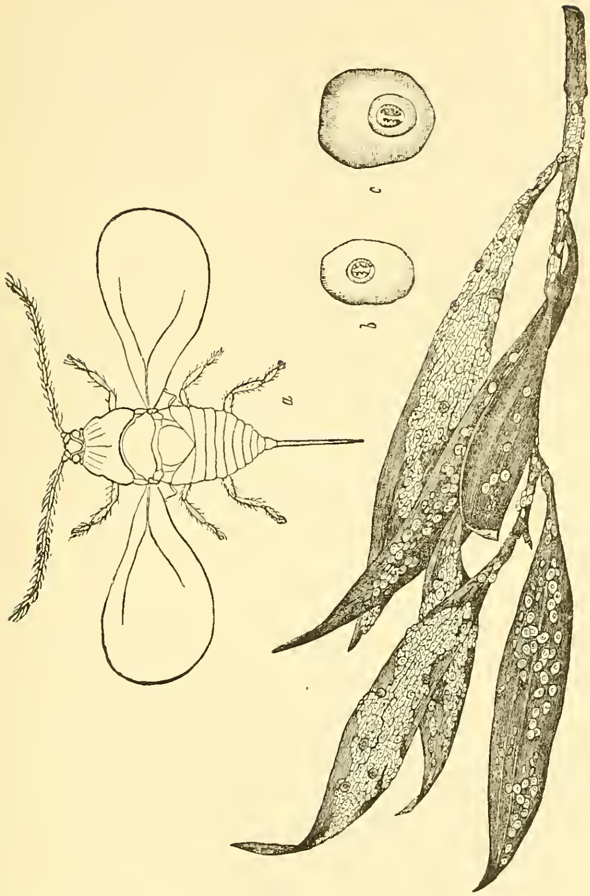
The Placid Soldier-bug shown in Fig. 33, a, enlarged, and natural size below, is known to destroy them. This insect or one related to it is reported by Mr. E. W. Merritt of Houlton, Me., as feeding upon the larvæ, piercing them with its short beak and then sucking them dry. This insect should not be destroyed. It may be known by the following description: Head, thorax and legs black; abdomen, red, with an elongated black spot in the middle, crossed by a white line.

THE WHITE SCALE,

Aspidiotus nerii, Bonchè.

Specimens of this insect were received upon the leaves of the English Ivy. The plants were so badly infested that the leaves were nearly white with the scales. The lady sending the specimens stated that she had some time before placed leaves with the white spots on them, which came from a neighbor's, on a shelf near her plant, which would account for the attack. This insect attacks the orange and lemon trees in Southern California and Florida besides a number of other trees and plants. The Fig. 34 we give shows an acacia twig infested by this insect, the scales showing natural size.

FIG. 34.



The female scale is shown (Fig. 34, c) enlarged. The real size is about one-twelfth of an inch and the color whitish or light gray.

The male scale (Fig 34, b.) is about one twenty-fifth of an inch long and white with a tinge of yellow.

The winged male is shown (Fig 34, a.) highly magnified. It is yellow, mottled with reddish brown and has transparent wings.

REMEDY.

Wash the stems and leaves with whale-oil soap and water or by means of a sponge apply occasionally a thin coating of kerosene or sweet oil to the leaves and stems.

THE BLACK SWALLOW-TAIL.

Papilio Asterias, Cramer.

The larva of this insect was received from two parties with complaints of its ravages upon parsnips, carrots and celery. It is commonly known as the Parsley worm but feeds upon many plants cultivated and wild that belong to the Parsley family.

DESCRIPTION.

The perfect male insect is a black butterfly with a double row of yellow spots on its back; a broad band composed of yellow spots across the wings and a row of yellow spots near the hind margin; hind wings tailed and have seven blue spots between the yellow band and the outer row of yellow spots, and near the inner angle is an orange spot with a black center. Paler below and spotted with orange. The female has only a few indistinct yellow spots on the upper side of the wings. Expanse of wing three and a half to four inches.

Larva when full grown is about an inch and a half long and of a delicate apple-green or greenish-yellow color above, paler on the sides and whitish below. The body is transversely banded with black, each band bearing a row of six yellow spots. When disturbed the caterpillar thrusts out from the first or second segment of the head, an orange Y shaped organ, which emits a disagreeable odor.

Pupa an inch and a quarter long, pale green ochre yellow or ash gray in color; there are two short ear-like projections above the head. Pupa attached by the tail to a pad of silk and supported across the middle of the body by a loop of silk.

LIFE HISTORY.

The butterflies appear in June and lay the eggs upon carrots, parsnips, celery, caraway and other umbelliferous plants. The worms, after several molts, are mature in about a month, leave the plants and finding a suitable place on a fence, building, or trunk of a tree, make the silken pad and loop, and in a day or so changes to the pupa. In from nine to fifteen days, depending on the weather, the butterfly emerges, and in due time lays eggs which hatch. These larvæ mature and enter the pupa state in the fall and remain in this condition until the following spring, when the butterflies emerge, completing the life history.

REMEDIES.

Hand pinch the larvæ and pupæ and destroy them. Chickens and insectiverons birds will eat them.

THE EYED ELATOR.

Alans oculatus (Linn.)

We received from Mr. E. W. Shepherd of Jefferson, Me., the past season what seems to be the half-grown larva of the above species, said to have been taken from the trunk of a small apple tree. This insect belongs to the spring beetle family, the larvæ of which usually are found under the bark of trees, or boring in decaying wood. To find one boring in sound wood is unusual and for *this* species novel so far as we know. The above species is the largest of the family and the perfect insect is a handsome beetle over an inch long of a grayish color with two prominent black eye-like spots on the thorax. Smaller species of the same family are common and they all attract attention by their power to spring when placed on their back. The above species is not liable to do much injury.

THE HAWTHORN TINGIS.

Corythuca arcuata.

This species was found in abundance feeding upon the foliage of butternut trees in the western part of the State. They are not likely to do much damage and deserve only a passing notice. By cleaning the ground under the trees in the fall and burning the rubbish a great many of them would be destroyed.

THE MOURNING-CLOAK BUTTERFLY.

Vanessa antiopa, Linn.

The larva of this species was quite abundant the past season about Orono and in other portions of the State, feeding upon the foliage of the elm. This species feeds also on the willow poplar but attracts more attention when devastating our favorite shade tree.

DESCRIPTION.

The *perfect insect* is a beautiful butterfly with two and a half to three inches expanse of wing. It may be known by the purplish or reddish brown wings bordered by a yellowish or buff band, within which is a row of violet blue spots. *Eggs* pale yellow and ribbed. A dozen or more are deposited on the stem near the petiole of a leaf.

The *larva* when mature is about one and three-fourths inches long; black, minutely dotted with white and appearing grayish; back marked by a row of eight bright brick red spots. The body is armed with from four to seven stiff branding spines on each segment except the first, giving the caterpillar a formidable appearance. The larva are social in their habits feeding in groups on the foliage. Chrysalis dark brown, with large tawny spots around the tubercles on the back.

LIFE HISTORY.

The butterflies hybernate in some sheltered place and are on the wing in the spring before the snow is gone, and lay their eggs for the first brood, which in this region hatches in June, and the larva are mature late in July or early in August, enter the chrysalis state and the butterfly emerges in ten or twelve days.

This brood soon lays eggs, which hatch and the larvæ mature; enter the pupa state and emerge before fall, producing the hybernating brood, completing the life history.

REMEDIES.

We find but few remedies suggested in the writings of entomologists but see no reason why they might not be destroyed by Paris Green on smaller trees and the branches of larger ones within reach of the spraying pump.

The natural enemies of this insect help to keep it in check. Out of half a dozen chrysalids put away to transform by Mr. Briggs, only two butterflies emerged and from all the others there came numerous small ichneumon flies. From one of the chrysalids over one hundred and fifty came forth. Some of the specimens were sent to Mr. Howard of the Agricultural Department at Washington, and he called them *Pteromalus pupasum*. We do not know of this species having been found before parasitic on the larva of this butterfly, though another species *Petromalus vanessæ*, Harris, with this habit is recorded.

THE MEAL WORM.

Tenebrio molitor.

The perfect insect of this species was received from Mr. George L. Coffin, Winthrop, Me., who "found large quantities in corn meal." The perfect insect is a plain black beetle six-tenths of an inch long. The larva is about an inch long, cylindrical, smooth, glossy, hard, and of a yellowish brown color. It is known to infest corn meal, rye meal, boxed crackers, biscuits, &c., and is often found where grain is stored We know of no remedy for them beyond killing as many of the beetles and larvæ as possible when found.

BENEFICIAL INSECTS.

All insects are not injurious. The indiscriminate killing of insects should be guarded against, as one's friends are as likely to suffer as his enemies. There are a large number of parasitic insects which render great service to the farmer and fruit grower by feeding on injurious insects. These should be recognized when seen, protected and encouraged.

Attention is called to the *lady birds*, ichneumon flies, tachina flies and ground beetles illustrated in this report. The lady birds are small, *turtle shaped* beetles usually with spots on the wing covers. The beetles and their larvæ destroy the eggs of a number of injurious insects. They should be protected. Two forms are shown, Fig. 7 and Fig. 23.

Ichneumon flies have four wings and are related to the wasps and bees. There are numerous minute forms that prey upon the eggs and larvæ of injurious insects, and larger forms that deposit their eggs on caterpillars, destroying them. Figs. 3, 12 and 13, will show the nature of these beneficial insects. The two-winged flies are sometimes parasitic on injurious insects. A tachina fly with that habit is shown in Fig. 14.

The predaceous beetles are carnivorous, feeding upon the larva and perfect form of other insects. They are quick moving beetles with long legs and generally metallic or black color. Two forms are shown in Figs. 15 and 16.

INSECTICIDES.

Experiments have been made the last season with the following insecticides, viz: Paris Green, London Purple, Hammond's Slug

Shot, Peroxide of Silicates, and Doyen's Potato-bug Prevention, to determine their relative value in destroying the potato beetle. The Paris Green was applied with an ordinary water sprinkler, using one teaspoonful to two gallons of water with satisfactory results. The London Purple was applied in the same way, but one tablespoonful to two gallons of water. Results not as satisfactory as with Paris Green. The Peroxide of Silicates and Hammond's Slug Shot were sifted on the potatoes from a small box with a fine wire screen bottom, at the rate of sixty pounds to the acre. The former scorched the leaves. Both killed the beetles. A partial analysis was made of *Doyen's Potato-bug Preventive* but no experiments were performed with it at the station, though some of it was tried about Orono with negative results.

In all of these the poisonous ingredient must be arsenious acid (oxide) or its compounds, so that in each case the value of the preparation as an insecticide is determined approximately by the amount of arsenious acid present. The following are the results of the analyses of the above named materials.

	Paris Green, Per cent.	London Purple, Per cent.	Hammond's Slug Shot, Per cent.	Peroxide of Silicates.	Doyen's Potato Bug Preventive.
Arsenious Oxide (white arsenic)......	47.68	55.35	1.20	1.61	19.09
Cupric Oxide....................	27.47				7.41
Calcium Oxide (lime).............	–	26 23	29 41	34 75	
Sulphuric Acid (anhydride)..........	.78	.22	42.05	49.66	
Carbonic Acid....................	–	.27			
Acetic Acid......................	7.16				
"Dead oil" (by difference)*..........	–	–	5.00		
Insoluble residue..................	2.34				
Water of hydration (calculated)......	–	–	18.91		
Moisture.........................	1.35	5.29	3.43		

*Also determined approximately.

The Paris Green is mainly an aceto-arsenite of copper, or in other words, a compound of acetic acid, arsenious acid and copper. The London Purple is composed mainly of arsenite of lime, containing, besides, quite an amount of coloring matter. It is quite variable in composition.

Hammond's Slug Shot does not make a good showing as over nine-tenths (exactly 90.37 per cent) of it appears to be nothing but plaster. It contains only 1.2 per cent of arsenious acid, and approximately 5.00 per cent of a heavy oil.

Peroxide of Silicates contains only 1.61 per cent of arsenious acid and 84.41 per cent of calcium sulphate. A large part of the calcium sulphate is anhydrous and may have been added either as the mineral anhydrite or as Plaster of Paris.

Doyen's Potato-bug Preventive contains 19.09 per cent of arsenious acid and 7.41 per cent of copper oxide. The remainder consists chiefly of starch in large fragments. The presence of copper oxide and the green color of the mixture indicate, that the arsenic was added in the form of Paris Green.

Paris Green contains about forty times as much arsenious acid as Hammond's Slug Shot and the London Purple analyzed over forty-six times as much. Peroxide of Silicates is but little better than Hammond's Slug Shot. A mixture equally as strong as Hammond's Slug Shot can be made by mixing two and three-fourths lbs. of Paris Green with one hundred lbs. of plaster, and a mixture as good as Peroxide of Silicates by mixing three lbs. of Paris Green with one hundred lbs. of plaster. The heavy oil in Hammond's Slug Shot is probably no benefit, as the mixture contains enough arsenious oxide to kill the beetles without it.

Doyen's Potato-bug Preventive cannot be compared with the others, as the directions require a different method of application. This insecticide is put up in small wooden boxes holding an ounce and a half of what appears to be merely a mixture of about four parts of starch and one part of Paris Green. It is retailed at the modest sum of fifty cents per box. A similar mixture could be prepared from four parts of flour and one part of Paris Green, at a cost of less than one cent per box. Flour, which is cheaper than starch and just as good, has long been used as a carrier for Paris Green. The novelty of this insecticide is the method of application as shown by the following directions pasted on each box:

"A HALF HOUR'S WORK TO THE ACRE SAVES THE CROP.

Directions for use—Take two tablespoonfuls of the powder and put it into a ten quart pail; then add three quarts of boiling water. Fill the pail with potatoes cut in small pieces; then fill the pail with water so as to cover the potatoes, and let stand over night or longer. Just before the potatoes come up, scatter the pieces over the ground. This is enough for one acre. Price 50 cents."

The millennium in potato raising would certainly be here, if by "a half hour's labor to the acre" at a cost of "fifty cents" we could "save the crop" from the ravages of the "potato bug."

If potato beetles would all come out of the ground before the potato tops appear, and could be assembled to partake of the inviting feast spread for them, their destruction would be inevitable. But as they prefer not to appear much before early potatoes are up, and continue to emerge for a month or six weeks; and as they will fly a long way in search of their favorite food and will not eat the tubers when young tops are to be had, there seems to be great difficulty in fulfilling the necessary conditions. As it might be difficult to induce the beetles to change their tastes and habits probably the safest and most economical plan would be to use the cheaper mixtures of Paris Green and apply them in the ordinary way. This insecticide was tried by two parties at Orono without any apparent "substantial benefit", as the usual applications of Paris Green had to be made later in the season.

RELATIVE COST.

Hammond's Slug Shot, 100 lbs.,	$5.00
Peroxide of Silicates, 100 lbs.,	4.00
London Purple, 2 lbs. 40 cts., 100 lbs. plaster 50 cts =	.90
Paris Green, 3 lbs. 70 cts., 100 lbs. plaster 50 cts. =	1.25
Paris Green, 2 lbs. 50 cts., 100 lbs plaster 50 cts. =	1.00
Paris Green, 1 lb. 25 cts., 100 lbs. plaster 50 cts. =	.75
Paris Green, ½ lb. 15 cts., 100 lbs. plaster 50 cts. =	.65

Hammond's Slug Shot and Peroxide of Silicates will kill insects effectually. It is not a question of efficiency, however, but one of relative cost. For garden use where only a few pounds are needed many would prefer to pay a good price for an insecticide than to take the trouble to prepare one. Most farmers who use considerable quantity rather buy the plaster and Paris Green and mix them, than to pay three or four dollars per hundred pounds to have it done for them.

In the above table we have for the sake of comparison of cost used two pounds London Purple to one hundred pounds of plaster, and three pounds of Paris Green to one hundred pounds of plaster. Experience shows that these strong mixtures are unnecessary, scorch the leaves and are a waste of material. Economy would suggest the use of as weak an insecticide as possible and yet secure good results.

Hammond's Slug Shot and Peroxide of Silicates contain considerable more arsenious acid than is necessary to kill the beetles.

One pound of London Purple to one hundred pounds of plaster is the strongest mixture advisable and the work can be done with less.

The strongest mixture of Paris Green advised would be two pounds to one hundred pounds of plaster, and there is good reason for believing that one pound to one hundred or even two hundred pounds of plaster, when thoroughly mixed and well applied, is sufficient.

The cheapest and most efficient poison for potato beetles is *Paris Green* applied with plaster or in suspension in water.

If plaster is not useful as a fertilizer on the land the cost could be still further reduced by applying the Paris Green in water, at the rate of one pound to eighty gallons. This method has the advantages of less cost, greater rapidity of application, more equable distribution and no danger of inhaling the poison. The Paris Green is insoluble in water and has to be kept thoroughly stirred if an even application is desired. This is easily accomplished with as little trouble as mixing the Paris Green with plaster. An ordinary sprinkler with a *fine vase* serves a good purpose in making the application.

SPRAYING TREES.

Spraying fruit trees with insecticides in solution, or suspension in water about the time the young fruit is forming, has become a common practice, and has been attended with good results. Paris Green, suspended in water, one pound to eighty gallons, applied thoroughly with a spraying pump with a spray nozzle, two gallons to the tree, has given good results. The ravages of the coddling moth, canker-worm, plum curculio and other insects are said to be materially checked by this treatment at a cost of ten cents per tree.

The station has tried "Lewis's Combination Hand Force-Pump" manufactured by Lewis & Cowles, Catskill, N. Y., and find it a handy instrument well adapted to the uses of the farm and orchard. It is a brass pump and will readily throw water to the top of orchard trees from the ground or from a wagon. It can be used as a veterinary or agricultural syringe, or as a force pump. The instrument retails at six dollars. Every farmer or fruit grower ought to own some kind of a force pump.

REMEDY FOR ANTS.

Inquiries have been made for a way to exterminate field ants. Below we give the method advised, thinking it may be useful to some.

With a crowbar or some other instrument make three or four holes in different parts of the nest, extending to the bottom. By means of a tin tube, which any tinman can make, pour a few tablespoonfuls of kerosene oil to the bottom of each hole. Stop the holes with dirt and when convenient throw some dirt over the hill to keep the ants in. The kerosene oil will volatilize, permeate the chambers of the nest and kill the ants. When Bi-sulphide of Carbon can be obtained, perhaps it would serve a better purpose, being more volatile.

REMARKS.

The entomologist for the station desires to become acquainted with insects doing injury in the State to farm and garden crops, orchards and forest trees, also parasites upon domestic animals, or any insects in the State whether injurious, beneficial or neutral in their habits. Correspondence in regard to insects is cordially solicited and any one finding specimens not known is invited to send them here for determination. Below we give directions for sending specimens:

DIRECTIONS FOR SENDING SPECIMENS.

All inquiries about insects, injurious or otherwise, should be accompanied by specimens, the more the better. Such specimens if dead, should be packed in some soft material, as cotton or wool, and enclosed in a stout tin or wooden box. They will come by mail for one cent per ounce. INSECTS SHOULD NEVER BE ENCLOSED LOOSE IN THE LETTER. Whenever possible, larvæ (*i. e.* grubs, caterpillars, maggots, etc.) should be packed alive in a tight box—the tighter the better, as air-holes are not needed—along with a supply of their appropriate food sufficient to last them on their journey; otherwise they generally die on the road and shrivel up. Send as full an account as possible of the habits of the insect respecting which you desire information; for example, what plant or plants it infests, whether it destroys the leaves, the buds, the twigs, or the stem; how long it has been known to you; what amount of damage it has done, etc. Such particulars are often not only of high scientific interest, but of great practical importance. In sending soft insects or larvæ that have been killed in alcohol, they should be packed in cotton saturated with alcohol. In sending pinned or mounted insects, always pin them securely in a box to be inclosed in a larger box, the space between the two boxes to be packed with some soft or elastic material, to prevent too violent jarring. PACKAGES SHOULD BE MARKED WITH THE NAME OF THE SENDER, and addressed to the entomologist for the Experiment Station, Orono, Me.

ANALYTICAL AND EXPERIMENTAL METHODS.

Protein Digestion.*

DIGESTIBILITY OF THE PROTEIN WITH ARTIFICIAL SOLUTIONS.

The methods employed in the artificial digestion experiments were essentially those finally proposed by Stützer, viz: the digestion of the finely ground substance for twenty-four hours in an acid pepsin solution at 40° C., followed by digestion with a solution of pancreas for the same time at the same temperature.

The variations in the methods were the use of scale pepsin instead of an extract from the inner membrane of a pig's stomach, the preparation of the pancreas solution in the way proposed by Dr. Chittenden, and in the case of the fodders from XXIX to 41 the digestion with pancreas for only twelve hours.

*Printed in advance nearly as given here in Agricultural Science November, 1888.

Digestibility of Protein by Pepsin-Pancreas Digestion.

		In water free substance.			Per cent total nitrogenous material digested.	Per cent. albuminoids digested.
		Total nitrogen per cent.	Albuminoid nitrogen, per cent.	Undigested by pepsin pancreas digestion.		
XXIV	Alsike clover.......... 1886	1.81	–	.87	52.0	
XLI......	" 1887	2.32	2.02	.457	80.3	77.4
XLII.....	White................ 1887	2.76	2.32	.502	81.8	78.4
XLIII...	Blue joint....... 1887	1.61	1.42	.525	67.4	63.0
XXVII...	Oat straw 1886	.63	–	.344	45.6	
XL.......	Orchard grass 1887	1.35	1.29	.393	70.9	69.6
L.........	Red Top 1887	1.55	–	.557	64.1	
XXIII....	Timothy 1886	1.07	–	.464	56.5	
XLIV	" 1887	1.31	1.17	.338	74.2	71.1
LI.......	" 1887	1.25	–	.465	62.8	
XLV	Wild oat grass... 1887	1.20	1.08	.414	65.5	61.7
XXXIX ..	Witch grass 1887	1.52	1.39	.325	78.7	76.6
XLVI	Buttercup... 1887	1.62	1.53	.391	75.9	74.5
XLVII ...	White weed 1887	1.49	1.40	.398	73.3	71.5

A Comparison of Methods for the Determination of the Digestibility of Protein.

A reference to the coefficients of digestibility previously given shows that the coefficients of digestibility for protein differ in a marked manner as determined by the natural and artificial methods. The latter method gives coefficients from 3.7 to 51. per cent higher than the former, as is shown in a subsequent table, where the two sets of figures are placed side by side. In one instance only does the artificial digestion give a lower result. It is important to know the cause of these differences. On the one hand we have the long confessed inaccuracy of considering the nitrogen of the feces as belonging entirely to the undigested protein, and on the other, it must be acknowledged that the treatment of the fodders with artificial digestive fluids is arbitrary and may not correspond in the extent of its action to that of the natural process of digestion.

The most promising direction in which to look for an explanation of widely different results for protein by the two methods seems to be in a study of the nitrogen compounds of the feces.

If by any means it is possible to separate the actual undigested residue of protein from the other nitrogen compounds of the solid excrement, we shall have a standard by which to judge artificial methods of digestion, as well as a means of correcting the coefficient of digestibility for protein, as usually calculated, if such correction is necessary.

Three methods have been tried for the separation of the biliary and other waste products (stoffwechselproducte) from the real undigested food residue, viz: (1) Successive treatment of the feces with ether, alcohol and hot water; (2) the same followed by cold lime water, and (3) digestion with a pepsin solution.

The treatment with ether was the same as for a fat extraction, and with the alcohol and water, 50 c. c. of each were used for each gram of substance, the solvents being added cold, brought quickly to the boiling point and kept at that temperature for about ten minutes, filtered at once, and the residue washed with the same liquid used for extraction.

The treatment with lime water consisted in letting one gram of the substance stand in 50 c. c. of a saturated solution for six hours in cold.

The pepsin solution was the same as that used in digestion of fodders, the time of treatment being twenty-four hours. The nitrogen was determined in the residues after extraction, and not in solution.

Determinations by two persons one using two grams of substance, and the other one gram, gave practically the same results.

In the table following can be seen the results of these different methods of treatment.

NITROGEN IN THE FECES.

		Nitrogen in 100 parts water-free feces				Per cent. of total nitrogen extracted by ether, alcohol and hot water.	Per cent. of total nitrogen extracted by ether, alcohol, hot water and cold lime water.	Per cent. of total nitrogen extracted by digestion with pepsin solution.
		Total	Extracted by ether, alcohol and hot water	Extracted by ether, alcohol, hot water and cold lime water.	Extracted by digestion with pepsin solution			
XXIV...	Alsike clover...	1.66	.20	24	.42	12.00	14.46	25.30
XXIV..	" "	1.67	.21	.25	.42	12.51	14.97	25.15
XLI......	" "	2.19	.32	.49	.84	14.61	22.46	38.36
XLII.....	White "	2.17	.33	.67	.91	15.21	30.87	41.93
XLIII ..	Blue joint	1.16	.22	.33	.46	18.96	28.45	39.65
XL.	Orchard grass...	1.22	.29	.43	.52	23.77	35.24	42.62
XXVII...	Oat straw.	1.43	.30	.37	.42	20.98	25.87	29.30
XXVII...	" "	1.35	.21	.40	.54	16.33	29.85	40.00
XXVII... XXX. ..	Oat straw, Raw potatoes, }	2.16	.51	.57	.98	23.61	26.39	45.37
XXVII... XXX. ..	Oat straw, Raw potatoes, }	2.04	.56	.67	1.12	27.45	32.84	54.90
L	Red top.	1.45		.29	.45	–	20.00	31.03
XXIII ..	Timothy	1.26	.27	.34	.47	21.43	26.98	37.01
XXIII...	"	1.18	.19	.28	.36	16.10	23.72	30.50
XLIV ..	"	1.51	.18	.36	.55	11.92	23.84	36.42
LI......	"	1.52		.34	.54		2[illegible].36	35.53
XLV	Wild oat grass....	1.53	.24	.42	.57	15.68	27.45	37.25
XXXIX ..	Witch grass...............	1.37	.24	.38	.53	17.52	24.20	38.69
XLVI ...	Buttercup	1.55		.35	.54	-	22.58	34.84
XLVII .	White weed	1.48	–	.27	.52	–	18.24	35.27
						17.87	24.78	36.79

A brief analysis of the above table shows that in 15 of the 19 experiments from 12.00 to 27.45 per cent, or an average of 17.87 per cent, of the fecal nitrogen was soluble in ether, alcohol and hot water, in the same cases additional treatment with cold lime water taking out an average of eight per cent. more, the amounts extracted by this latter solvent ranging in the several experiments from 2.46 to 15.66 per cent. of the total nitrogen.

The percentage of nitrogen, dissolved by the pepsin digestion was on the average 12 per cent. more than that extracted by the combined action of the other four solvents.

As is well known, the digestibility of protein, as shown in tables of fodder analyses, is calculated by assuming that all the nitrogen of the feces belongs to the undigested residue. The coefficients of digestibility previously given were so calculated.

In the next table these coefficients are compared with those obtained by reckoning as undigested nitrogenous material, that left in the feces after successive extraction with ether, alcohol, hot water and cold lime water, and after digestion with a pepsin solution, and also with the coefficients from a pepsin solution.

For convenience the four methods are designated as A, B, C, and D, respectively.

DIGESTIBILITY OF PROTEIN BY DIFFERENT METHODS.

		A.	B.		C.		D.	
		Results from experiments with animals by usual method of calculation.	After correction by extraction of feces with ether, alcohol, hot water and cold lime water.		After correction by digestion of feces with pepsin solution.		Artificial pepsin pancreas digestion.	
			Protein digested.	Excess over ordinary methods	Protein digested.	Excess over ordinary method	Protein digested.	Excess over ordinary method.
		%	%	%	%	%		%
XXIV...	Alsike clover	59.1	65.2	6.2	69.6	10.5	52.	—6.6
"	"	58.1	64.7	6.6	68.9	10 8		
XLI......	"	64.	72.1	8.1	77.9	13.9	80.3	16.3
XLII.....	White clover.....	73.3	81.5	8.2	84.5	11.2	81.8	8.5
XLIII....	Blue joint	56.4	69.	12.6	73.9	17.5	67 3	10.9
XL... ..	Orchard grass	58 5	73.3	14.8	75.7	17.2	70.8	12.3
XXVII...	Oat straw..	—15.2	13.1	28.6	19.	34.2	45 6	
" ...	"	—2.5	27.7	30.2	38.4	40.9		
XXVII.. XXX .	Oat straw and Raw potatoes	25.9	45.4	19.5	59.5	33 6	78.5	51.
XXVII... XXX. ..	Oat straw and Raw potatoes ..	29.	52.7	23 7	68.1	39.1		
L	Red top	60.4	68 4	8.0	72.6	12.2	64.1	3.7
XXIII....	Timothy.............	45.6	60.2	14.6	65.8	20.2	56.6	11.4
"	"	44.9	57.9	13.0	61.6	16.7		
XLIV ..	"	60.4	69.8	9.4	74.8	14.4	74.2	13.8
LI........	"	44 5	56.7	12.2	64.	19.5	63.	18.5
XLV . .	Wild oat grass	48 5	63.4	14.9	68.	19.5	65.4	16.9
XXXIX ..	Witch grass..........	64.2	73.9	9.7	80.5	16.3	78 7	14. 5
XLVI ...	Buttercup	57.8	67.5	9.7	72.6	14.8	75.8	18.0
XLVII...	White weed.........	58.4	65.7	8.3	72.8	14 4	73.3	14.9

It appears that method A, gives uniformly much lower results than either of the other three methods, method C, giving the highest. The average coefficients obtained by the four methods in 15 of the 19 trials, excluding the experiments where oat straw alone, and oat straw with potatoes were fed, are as follows:

Method A. 56.9 per cent.
" B. 67.3—10.4 above A.
" C. 72.2—15.3 " "
" D. 67.5—10.6 " "

The increase in coefficients of digestibility due to the corrections applied, range in the 15 experiments from 6 per cent to 14.9 per cent with method B, and from 10.5 per cent to 20.2 per cent with method C. In those experiments where the daily ration was only 350 grains of oat straw, or 350 grains of oat straw and 1000 grains of raw potatoes, the amount of nitrogen extracted as presumable *stoffwechselproducte* is relatively much larger, and in these instances the coefficients by method B, are from 19.5 per cent to 30.2 per cent, and by method C, from 33.6 per cent to 40.9 per cent larger than by method A.

The large differences in the results by the three methods in these two experiments are due to the fact that in one case an abnormally small amount was fed of a food poor in nitrogenous material, and that in the other, the amount of material added to the oat straw contained a relatively large quantity of digestible substance as compared to the additional protein consumed.

The amount of waste nitrogenous products in the feces, such as biliary compounds, etc., seems to be determined by the "wear and tear" of the digestive apparatus, and not by the quantity of nitrogen in the food.

This "wear and tear" within a given time is proportionate, we may believe, to the amount of food digested. The next table shows that the nitrogenous material extracted from the feces by method B, bears a more nearly fixed relation to the material digested than to the protein fed.

The error involved in method A, is in general, inversely to the amount of nitrogen in the food. The corrections of methods B and C then, affect the coefficients for oat straw and timothy much more than that for clover hay.

		Protein fed daily—grams.	Organic matter digested daily—grams.	Nitrogen extracted from feces by successive treatment with ether, alcohol, hot water and cold lime water.		
				Per day—grms.	For each 100 grs. organic mat. digested—grams.	For each 100 grs. of protein fed—grams.
XXIV....	Alsike clover...........	70.4	344.0	.68	.20	.96
XLI......	"	88.8	349.5	1.14	.33	1.30
XLII.....	White clover...........	105.8	374.0	1.40	.37	1.32
XLIII....	Blue joint	64.3	251.5	1.27	.50	1.97
XL.......	Orchard grass..........	52.5	323.7	1.22	.37	2.32
XXVII...	Oat straw..............	12.5	158.6	.60	.38	4.80
XXVII... XXX	Oat straw and raw potatoes...............	38.9	342.6	1.33	.39	3.42
L.........	Red top	59.8	347 6	.76	.22	1.27
XXIII....	Timothy................	41.6	320.4	.99	.31	2.38
XLIV ...	"	52.5	408.9	.79	.19	1.50
LI........	"	41.1	276.2	.82	.30	2.00
XLV	Wild oat grass..........	48.0	378.9	1.09	.29	2.27
XXXIX ..	Witch grass............	59.5	360.1	.95	.26	1.59
XLVI.....	Buttercup	63.4	331.3	.92	.28	1.45
XLVII ...	White weed............	59.1	340.7	.72	.21	1.22

The value of the foregoing observations as an aid in solving the problem of protein digestion must be decided according to the answer given to the following question: Do the solvents used in methods B and C extract from the feces any of the undigested protein? If not, then there seems to be good reason for applying some method of correction to the coefficients of digestibility of protein as usually determined. If nitrogenous waste products are present in the feces to the extent these methods indicate, the error they cause is too large to be ignored.

Let us first consider method B. The solvents used are ether, hot alcohol, hot water and cold lime water.

It seems to be generally acknowledged that the ether and alcohol remove only biliary products. This assumption may safely be regarded as correct, unless the feces contain amides, certain acid amides at least being soluble in both these liquids. If amides or peptones are present, then the extraction with hot water is also not allowable; otherwise it would seem to be, for it is not probable that treatment of the feces for ten minutes with hot water would dissolve any albuminoids that had withstood the long-continued action of the digestive fluids.

In fact Dr. Armsby's work on the separation of albuminoids from amide nitrogen in hays shows that treatment with hot water extracted no more nitrogen than Stützer's method where a precipitant is used to bring down any albuminoids that might be in the water solution.

It seems hardly probable that the feces contain peptones or amides.

These are compounds soluble in water, and are those into which the albuminoids of the food are transformed in order that they may be resorbed. It seems as probable that these substances should be wholly resorbed as that sugar should be, which is either in the food or is formed from the starch of the food, and as can be seen later, the feces examined in these experiments were found to contain no sugar

In future work, however, tests will be made for peptones and amides.

An examination of the figures given shows that the action of cold lime water for six hours removed considerable nitrogen not taken out by the other three solvents. Did any of this nitrogen come from the albuminoids of the feces?

The results of an experiment with two hays indicate a negative answer to this question

Hays XLII and LI were submitted to an ordinary pepsin digestion for twenty-four hours, and also to the usual pepsin-pancreas digestion, after which they were allowed to stand for different lengths of time in a cold saturated solution of calcium hydrate. Below are the figures showing the nitrogen in the hays before and after standing in the solution.

		Nitrogen in residue after pepsin digestion.	Nitrogen in residue after pepsin pancreas digestion	Nitrogen in residue after additional treatment with cold lime water.				
				1h.	2 hrs	4 hrs.	6 hrs.	36 hrs.
		%	%	%	%	%	%	%
XLII.....	White clover hay.....	-	.49	-	-	-	.46	
LI	Timothy hay	.41	.45	.43	.42	.43	.40	.39

As has been observed, the digestion with a pepsin solution extracts more fecal nitrogen than method B. Does method C extract too much? It now seems to the writer that there is some reason for thinking that it does. By method B the nitrogen extracted is that which is readily and immediately dissolved, while the pepsin solution continues to remove an increasing quantity up to 24 hours' digestion, and perhaps farther. This matter was made the subject of but one experiment The feces from LI were treated with pepsin solution for six, twelve, eighteen and twenty-four hours, the nitrogen in the water-free residues being 1.19, 1.08, 1.04, and .99 per cent respectively.

Again the results by method C average considerably higher than by methods B and D (pepsin-pancreas digestion), while the two latter agree closely with each other.

Nearly twenty digestion experiments are now being planned for the next year's work at this station, and an effort will be made to so increase the data bearing on the main points here presented, that more definite conclusions can be reached.

REPORT OF CHEMIST.

J. M. BARTLETT.

FERTILIZERS.

The official methods adopted by the Association of Official Agricultural Chemists (see bulletin No. 16, U. S. D'p't of Agr'l,) have been quite closely followed, therefore only the most important variations are published below.

Soluble Phosphoric Acid.

In this determination the substance is brought directly upon a filter and leached with 300 to 350 c. c. water into a 400 c. c. flask, care being taken to add the water in small portions at first, and allow each portion to run through before adding a new one. After the leaching is completed the solution is made up to the mark and 100 c. c. taken for analysis. This seems to us the simplest and best method yet recommended, as we get no higher results by following the official directions. Washing by decantation from a beaker is especially objectionable with phosphates, that revert rapidly, as quite a portion of the phosphoric acid is precipitated in the beaker and remains on the filter.

In many instances only 15 to 20 minutes time has been allowed for the precipitation of phosphoric acid with ammonium molybdate, and it has always been found to be completely precipitated.

Potash.

The same method as employed heretofore and described in Maine Experiment Station report for 1886–1887 has been used, as it has required less time than the Gladding method and gives accurate results.

Nitrogen.

When nitrates were present a modification of the Kjeldahl Jodlbauer method which was worked up and tested at this station during the summer of 1887 but not published heretofore, has been used. Practically the same method has been suggested and tested by other chemists since that time with good results.

The method is as follows :—1 gram finely powdered substance is introduced into a dry digestion flask, 30 c. c. concentrated sulphuric acid containing 1¼ grams phenol added, shaken until thoroughly mixed and allowed to stand ten minutes at ordinary temperature. One-half to two grams powdered zinc is then added, the flask placed over a very low flame and heated cautiously for 15 minutes, when about 7 grams mercury is added and the flame increased sufficiently to boil the acid. The remainder of the process does not differ from the regular Kjeldahl method.

This method has proved very reliable when properly worked. The only precautions necessary to secure good results are, to mix the substance with the acid and phenol, thoroughly, before adding zinc or heating, and to have the flame very low on beginning to heat. The following table shows the results obtained with pure nitrates and fertilizers containing nitrates. Samples I to V inclusive were prepared from fertilizers containing only organic nitrogen and ammonium salts. The nitrogen was carefully determined in them and a weighed amount of pure nitrate added to each. A few determinations were made with benzoic acid substituted for phenol—a modification of Asboth's method.

	Number.	Nitrogen as Nitrates.	Total Nitrogen Kjeldahl Asboth Modification.	Total Nitrogen Kjeldahl Jodlbauer Modification.	Calculated.
		%	%	%	%
Potassium nitrate, c p....	–	13.86	13.84	13.86	13.86
" "	–	–	13.87	13.93	"
" "	–	–	13.84	13.75	"
" "	–	–	–	13.82	"
Fertilizer	I	.42	–	3.75	3.73
"	I	.42	–	3.78	–
"	II	.69	3.90	3.94	3.93
"	II	.69	3.92	3.92	–
"	III	1.386	–	4.53	4.55
"	III	1.386		4.49	
"	IV	"	–	3.89	3.93
"	IV	"	–	3.96	"
"	IV	"	–	3.92	"
"	IV	"	–	3 96	"
"	V	"	4.01	3.98	3.96
"	V	"	3.97	4.07	"
"	V	"	–	4 04	"
"	V	"	–	4 00	"
"	V	"	–	3.98	Copper Oxide.
"	VI	.42	–	2.64	2.60
"	VI	.42	–	2.55	–
"	VII	.79	–	2.48	2.47
"	VIII	.83	–	1.45	1.45
"	IX	.63	–	2.39	2 49
"	X	.54	–	3.00	3.05
"	XI	.86	1.94	1.96	1.89
"	XII	2.72	–	2.96	3.05
"	XIII	1.59	–	3 25	3.21
"	XIV		–	2.98	2.89

Prof. Scoville's method with salicylic acid has also been given a trial, and results were satisfactory, but thus far, we fail to see that it has any advantages over the Kjeldahl Jodlbauer modification

MILK.

Solids.

A small quantity of asbestose, sufficient to absorb two grams of milk, is placed in a two and one-half inch watch-glass, deepest form, lined with tinfoil. This is dried at 100° and together with its cover and clamp, is weighed. About two grams of milk are then run from a pipette on the asbestose and the whole weighed again, dried for two hours at 100° C. cooled and finally weighed. First weight subtracted from the last gives weight of solids.

By using watch-glasses ground together and clamped the use of a desiccato is avoided unless the weighing is to be deferred for quite a time.

Fat.

The portion dried for solids is removed from the watch-glass, the tinfoil drawn to a thimble form around the asbestose, perforated with a pin, placed in the extracter, the fat extracted with ether and dried for one hour at 100° C. and weighed.

Nitrogen.

About two grams of milk are run into the flask from a weighing pipette and without drying down the nitrogen is determined by Kjeldahl method using only 10 c. c. sulphuric acid. Heat should be applied very gently and the flask shaken frequently until the water is boiled out, otherwise a loss of nitrogen may occur from the milk spattering on the hot walls of the flask and burning off.

Ash.

Two grams are ignited at a low red heat in a platinum dish till constant weight is obtained.

SUGAR AND STARCH IN COARSE FODDERS.

Sugars.

Five grams of the finely powdered substance are placed in a beaker, 100 c. c. water at 40° C. added and allowed to stand for one-half hour, with frequent shaking. The extract is then filtered through paper into a 250 c. c. flask, the substance brought upon the filter and leached with water at ordinary temperature till the solution is made up to 250 c. c.

Twenty-five c. c. of this solution are taken for determination of glucose and another portion of twenty-five c. c. is heated, after adding a few drops of HCl, in a covered beaker on the steam bath, for one-half hour, then neutralized with KHO and total sugar determined.

Allihn's method and tables* were used in all cases for all sugar determinations, except that instead of reducing the copper oxide to copper it was ignited and weighed as CuO and the Cu calculated. Several comparisons showed this method to be accurate.

*Freseneus's Quan. Chem. Analysis, 6th Ed., p. p. 595-597.

	Milligrams. Cu reduced.	Milligrams. Cu calculated from Cu O.
Determination I	.0715	.0718
" II	.378	.379
" III	.380	.375

Starch.

The five grams that have been leached for sugars are washed into a flask with 150 c. c. water, the flask attached to a condenser to prevent the escape of steam and the contents boiled for one-half hour. Then fifty c. c. of a two per cent solution of HCl are added and the boiling continued for one-half hour more, the solution filtered through linen into a beaker and the residue thoroughly washed with hot water. (The washing is much facilitated by wringing the water completely out each time before adding a new portion). The beaker is then placed on a steam bath, the solution evaporated to nearly 200 c. c. and 15 c. c. HCl (Spc. grav. 1.12) added and the heating continued for three hours. The solution is then filtered if necessary, transferred to a 250 c. c. flask, made slighdy alkaline with KHO, filled to the mark and filtered through dry filter. Twenty-five c. c. are taken for each determination.

The above method was employed for the determination of starch in some coarse fodders and excrements where it was thought desirable to use a method that was compatible with our present one for determination of crude fibre. Most of the methods published heretofore subject the fodder to the direct action of the acid for the time required to convert the starch to sugar.

Such treatment will give a much larger percentage of starch than is found in the acid solution from a crude fibre determination, and will also reduce the total amount of fibre in about the same proportion. A few comparative tests were made with the method recently published by Mr. E. F. Ladd,* in which the fodder is treated with 150 c. c. water containing four to five c. c. concentrated HCl for twelve hours at 100° C.

A sample of Timothy treated by this method gave about seven per cent more starch than the method described above, and to ascertain whether the cellulose was very much acted on, a crude fibre determination was made, treating the fodder with 200 c. c. water

*Sixth Annual Report N. Y. Agricultural Experiment Station, p. 462.

containing 5 c. c. concentrated HCl at 100° C. for eight hours, then one-half hour with alkali as by the regular crude fibre determination and the result was about five per cent less fibre than when treated one-half hour with one and one-fourth per cent sulphuric acid in the usual manner. As a further test, five grams of crude fibre were treated by Mr. Ladd's method and the extract tested with Fehling solution. The amount of copper oxide precipitated was equivalent to six and four-tenths per cent of starch.

By boiling a fodder one-half hour with a one-half per cent HCl solution as much material that reduces Fehling solution is rendered soluble as when a 1.25 per cent Sulphuric Acid is used. The following fodders were treated with both acids.

	Equal to Starch.	
	One-half per cent. HCl.	One and one-quarter per cent. H_2SO_4
Sample A, Corn fodder	13.7	12.7
" B, Red top	15.16	16.0
" C, Timothy	13.80	13.5
" D, Alsike clover	9.31	9.17

HCl was employed to bring the starch into solution for the reason that it is considered more favorable to the conversion of starch to sugar than sulphuric acid, and a mixture of acids during the latter part of the process was not desirable.

The strength required was determined by making a number of crude fibre determinations, substituting HCl solutions of varying strengths for the 1.25 sulphuric acid, until one was found that gave practically the same crude fibre.

The treatment with acid removes nearly all the matter that reduces Fehling solution which is extracted in a crude fibre determination, but a small amount being found in the alkali solution. Several alkali solutions that were examined contained less than two per cent and as high a percentage of starch was obtained by boiling the substance one-half hour with water previous to treating it with acid as when both alkali and acid solutions were used.

REPORT OF CHEMIST.

L. H. Merrill.

FODDER ANALYSIS.

With the exceptions noted below the methods used during the year have been those recommended by the American Association of Official Agricultural Chemists.

Ash—Crude ash was determined by burning two grams of the fodder at a low red heat in a platinum dish.

Ether Extract—One gram of the air-dry material was extracted for six hours. The extract was dried one hour at 100° and cooled in a desiccator.

Crude Fiber—Two grams were weighed into a round-bottomed flask of 500 c. c. capacity, 150 c. c. of water were added and the contents of the flask raised to the boiling point before the addition of the acid (50 c. c. of a 5 per cent solution.) The soda solution was added in a similar manner. During the boiling, the flask was connected with a condenser. Both filtrations were made upon linen. After the final washing with water, the fiber was transferred to a Gooch crucible, washed with alcohol and ether, and dried at 100°.

ARTIFICIAL DIGESTION.

The pepsin and pancreas solutions used in the work were prepared in the manner described in last year's report. The pepsin solution was allowed to act twenty-four hours (two days of twelve hours each.) The time for the pancreas digestion, however, was shortened to twelve hours. It is probable that even a shorter time would suffice (Stuetzer, Zeit. Phys. Chemie, xi. pp. 207-238,) but no experiments were made to test this point.

To ascertain the effect of reducing the time of the pepsin digestion, samples of corn meal and white clover were treated in the usual manner, while in a duplicate set the action of the pepsin was limited to twelve hours. The nitrogen found in the undigested residues is shown below.

	24 hs. pepsin, 12 hs. pancreas, per cent undigested,	12 hs. pepsin, 12 hs. pancreas, per cent undigested.
Corn Meal, XX,	.26	.42
White Clover, XIII.	.49	.54

A sheep excrement, after 6 hours with pepsin alone, gave nitrogen 1.12 per cent; after 12 hours, 1.02; 18 hours, .98; 24 hours, .93.

It would appear from these figures that the full effect of the pepsin is not obtained in 12 hours—at least, in the case of the materials named. In this work much depends upon the complete separation of the digestive fluids from the residue, and the careful washing of the latter. As a rule, the filtrations were effected with extreme difficulty, and a few anomalous results were manifestly due to the fact that a part of the digested material remained upon the filter.

The best results were obtained by the use of the "Best German" filter paper. Soft filters, 13 c. m in diameter, were selected and pleated. After the final washing no attempt was made to separate the residue from the paper. When dry, the tops of the filters were cut away, and the nitrogen determined in the whole by the Kjeldahl method.

LOSS OF NITROGEN FROM NITROGENOUS SUPERPHOSPHATES.

Andouard* calls attention to the loss of nitrogen which many superphosphates suffer through the decomposition of nitrates. This decomposition he believes to be due to the presence of free phosphoric, sulphuric or fluorhydric acids. The nitric acid thus set free escapes either unchanged or after reduction by the iron sulphide, ammonia salts or organic matters present

The statement has also been made that sodium nitrate undergoes decomposition in the presence of free sulphuric acid together with large quantities of iron sulphate and organic matters.†

In August 1887 six nitrogenous superphosphates were prepared in the station laboratory. They were mixed as follows:

1. 500 grams Dissolved Bone Black.
   100 " Sodium Nitrate.

*Comptes rendues, Tome CIV, Nr. 9, S. 583--585; Abs. Bied. Centralblatt, Mai, 1887, S. 304--305.

†Chemikerzeitung, 1887, Nr. 36; Abs. Bied, Centralblatt, Mai, 1887, S. 305.

2. 500 grams Dissolved Bone Black.
 60 " Sodium Nitrate.
 100 " Dried Blood.

3. 500 " Dissolved Bone Black.
 60 " Sodium Nitrate.
 100 " Dried Blood.
 60 " Ferrous Sulphate.

Samples 4, 5 and 6 were prepared as 1, 2 and 3 respectively, except that dissolved South Carolina Rock was substituted for the Bone Black. The superphosphates, after being finely ground and well mixed, were placed in wide-mouthed bottles, loosely stoppered and allowed to stand on the floor in one corner of the laboratory. From time to time the nitric acid and total nitrogen were determined in these samples. In order that the results might be compared, the moisture was also determined and all the results reduced to a water-free basis.

The first determinations of total nitrogen were made by the absolute method; the others by the modified Kjeldahl method. The results are given below.

	August, 1887.		October, 1887		December, 1887		July, 1888.		Dec'r, 1888.
	Total Nitrogen.	N. in Nitrate.	Total Nitrogen.	N. in Nitrate.	Total Nitrogen.	N. in Nitrate	Total Nitrogen.	N. in Nitrate.	Total Nitrogen
1	3.53	3.18	3.42	3.09	3.18	3.24	3.13	3.07	3.07
2	3.60	1.79	3.50	1.70	3.51	1.72	3.64	1.71	3.50
3	3.38	1.62	3.46	1.65	3.29	–	3.26	1.54	3.12
4	3.06	–	–	3.05	3.25	–	2.94	2.88	2.89
5	3.43	1.66	3.45	1.70	3.14	1.64	3.31	1.68	3.26
6	3.28	1.47	–	1.48	2.91	1.49	2.97	1.48	3.06

The amount of moisture present varied greatly from time to to time, and the apparent fluctuations in the amount of nitrogen was undoubtedly due in part to errors in reducing the results to a water-free basis.

Four months before the last determinations were made the samples were wet almost to a paste. Although the conditions were made as favorable as possible to the changes indicated by Andouard, yet the results obtained seem to show that the loss, if any, was trifling.

METHOD FOR PHOSPHORIC ACID.

Isbert and Stuetzer (Zeit. Anal. Chemie. 26, 583) propose a simplification of the ordinary method of determining phosphoric acid. The abridgement is based upon the constant relation which is said to exist between the ammonia and the phosphoric acid in the ammonium phospho-molybdate precipitate. These writers also claim that washing the yellow precipitate with cold water dissolves out the ammonium silico-molybdate which may be present, without removing any appreciable amount of phosphoric acid.

The method proposed is briefly this: The phosphoric acid is precipitated in the usual manner with ammonium molybdate, the precipitation being hastened by heating the solution to 60-70° C. for fifteen minutes. After cooling, the supernatant liquid is poured upon a filter, the precipitate washed several times by decantation with cold water, and the precipitate itself at last transferred to the filter. The washing is continued until the washings amount to one-fourth litre. The filter containing the precipitate is then transferred to a distillation flask, soda solution added, the ammonia distilled into standard sulphuric acid and determined by titration. The relation of nitrogen to phosphoric acid in the ammonium phospho-molybdate was found to be 1 : 1.654.

In order to test the applicability of this method to general laboratory use a number of trials were recently made at this station. The results obtained were not satisfactory. Moreover great difficulty was experienced in washing from the filter the last traces of ammonium nitrate contained in the molybdate solution. So much time was consumed in this way that the method was abandoned as being longer and less accurate than the gravimetric method in ordinary use.

As regards the use of cold water in washing the ammonium phospho-molybdate precipitate, it was found that in a few cases slightly lower results were obtained than when ammonium nitrate was employed. The differences were so slight, however, that it was decided to make this substitution in fertilizer analyses of the coming year.

LAWS.

Chapter 177, Public Laws of Maine, 1887.

AN ACT to regulate the sale and analysis of Commercial Fertilizers.

SECTION 1. The manufacturer, company, or person selling or offering for sale in this State, any commercial fertilizers exceeding ten dollars per ton in price shall, on or before the first day of March annually, or before offering the same for sale, register in the office of the department of the Maine State College of Agriculture and Mechanic Arts, known as the Agricultural Experiment Station, the name or trade mark under which the fertilizer is sold, the name of the manufacturer and the place of manufacture.

SEC. 2. Any manufacturer, company or person who shall offer, sell, or expose for sale in this State, any commercial fertilizer, the price of which exceeds ten dollars per ton, shall affix to every package, in a conspicuous place on the outside thereof, a plainly printed certificate, stating the number of net pounds in the package sold or offered for sale, the name or trade-mark under which the article is sold, the name of the manufacturer, and the place of manufacture, and a chemical analysis stating the percentage of nitrogen, or its equivalent in ammonia in available form, of potash soluble in water, and of phosphoric acid in available form, soluble or reverted, as well as the total phosphoric acid.

SEC. 3. Any representative or agent of said station is hereby empowered to select from three different parcels or packages of commercial fertilizers, taken from three different sections of the State, held or offered for sale in this State, quantities not exceeding two pounds from each package, which quantities shall be for analysis, and the average of the several analyses shall be taken to compare with the certificate found on the given packages, held or offered for sale; and said station may cause to be selected each year, at least three samples, as aforesaid, from each brand held for sale. The agent shall select these samples, in the presence of some representative of the company, from which the quantities are so selected, and shall deliver one-half of said samples, properly sealed by him, to said representative.

SEC. 4. Any person or party, who shall offer or expose for sale any commercial fertilizer, without complying with the requirements of sections one and two of this act, shall be fined not less than twenty-five dollars nor more than one hundred dollars for the first offense, and not less than one hundred dollars nor more than three hundred dollars for each subsequent offense.

SEC. 5. This act shall take effect October one, eighteen hundred and eighty-seven.

SEC. 6. All acts or parts of acts inconsistent with this act are hereby repealed.

Approved March 15th, 1887.

AN ACT to establish agricultural experiment stations in connection with the colleges established in the several States under the provisions of an act approved July 2, 1862, and of the acts supplementary thereto.

SECTION 1. Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture, and to promote scientific investigation and experiment respecting the principles and application of agricultural science, there shall be established, under direction of the college or colleges, or agricultural department of colleges, in each State or territory established, or which may hereafter be established, in accordance with the provisions of an act approved July 2, 1862, entitled "An act donating public lands to the several States and territories which may provide colleges for the benefit of agriculture and the mechanic arts," or any of the supplements to said act, a department to be known and designated as an "agricultural experiment station:" Provided, That in any State or territory in which two such colleges have been or may be so established, the appropriation hereinafter made to such State or territory shall be equally divided between such colleges, unless the Legislature of such State or territory shall otherwise direct.

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.

SEC. 3. That in order to secure, as far as practicable, uniformity of methods and results in the work of said stations, it shall be the duty of the United States commissioner 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 purposes of this act. It shall be the duty of each of said stations, annually, on or before the first day of February, to make the governor of the state or territory in which it is located, a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of said stations, to the said commissioner of agriculture, and to the secretary of the treasury of the United States.

SEC. 4. That 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. Such bulletins or reports, and the annual reports of said stations, shall be transmitted in the mails of the United States free of charge for postage, under such regulations as the postmaster general may from time to time prescribe.

SEC. 5. That for the purpose of paying the necessary expenses of conducting investigations and experiments and printing and distributing the results as hereinbefore described, the sum of $15,000 per annum is hereby appropriated to each state, to be specially provided for by Congress in the appropriations from year to year, and to each territory entitled under the provisions of section eight of this act, out of any money in the treasury proceeding from the sales of public lands, to be paid in equal quarterly payments on the first day of January, April, July and October in each year, to the treasurer or other officer duly appointed by the governing boards of said colleges to receive the same, the first payment to be made on the first day of October, eighteen hundred and eighty-seven: Provided, however, that out of the first annual appropriation so received by any station an amount not exceeding one-fifth may be expended in the erection, enlargement, or repair of a building or buildings necessary for carrying on the work of such station; and thereafter an amount not exceeding five per centum of such annual appropriation may be so expended.

Sec. 6. That whenever it shall appear to the Secretary of the Treasury, from the annual statement of receipts and expenditures of any of said stations that a portion of the preceding annual appropriation remains unexpended, such amount shall be deducted from the next succeeding annual appropriation to such station, in order that the amount of money appropriated to any station shall not exceed the amount actually and necessarily required for its maintenance and support.

Sec. 7. That nothing in this act shall be construed to impair or modify the legal relation existing between any of the said colleges and the government of the states and territories in which they are respectively located.

Sec. 8. That in states having colleges entitled under this section to the benefits of this act, and having also agricultural experiment stations established by law separate from said colleges, such states shall be authorized to apply such benefits to experiments at stations so established, by such states; and in case any state shall have established, under the provisions of said act of July 2 aforesaid, an agricultural department or experimental station in connection with any university, college, or institution not distinctively an agricultural college or school, and such state shall have established or shall hereafter establish a separate agricultural college or school, which shall have connected therewith an experimental farm or station, the legislature of such state may apply in whole or in part the appropriation by this act made, to such separate agricultural college or school; and no legislature shall, by contract, express or implied, disable itself from so doing.

Sec. 9. That the grants of moneys authorized by this act are made subject to the legislative assent of the several states and territories to the purpose of said grants: Provided, That payments of such installments of the appropriation herein made as shall become due to any state before the adjournment of the regular session of its legislature meeting next after the passage of this act shall be made upon the assent of the governor thereof duly certified to the Secretary of the Treasury.

Sec. 10. Nothing in this act shall be held or construed as binding the United States to continue any payment from the Treasury to any or all the states or institutions mentioned in this act, but Congress may at any time amend, suspend or repeal any or all of the provisions of this act.

INDEX.